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21—27 July 1957

The contributions to the previous symposia, excepting those to the very first one in 1939, have been published in Acta Radiologica. We now have the privilege to publish the majority of the papers presented at the 5th Symposium Neuroradiologicum in Bruxelles. A few of the papers read at the symposium have not been submitted for publication; these are indicated in the index given below.

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It has been the rule for the contributions in these special issues of Acta Radiologica not to be subjected to editorial revision to such an extent as are articles accepted for publication in our regular numbers. It is a matter of regret that the contributions in this issue vary so considerably from a scientific standpoint and that many of the authors do not always show adequate knowledge of the earlier pertinent literature. The papers presented have been arranged, within the subject divisions made, in the same sequence as in the preliminary program of the Symposium. The titles are in the same language as the subject matter, irrespective of the language in which they appeared in the program; the wording of some of the titles have also in some instances been slightly altered.

The Editor.

FROM THE DEPARTMENT OF NEUROLOGY (DIRECTOR: PROF. S. REFSUM), DEPARTMENT OF NEUROSURGERY (DIRECTOR: DOCENT G. RÖVIG; ACTING DIRECTOR: T. HAUGE), AND THE ROENTGEN DEPARTMENT (DIRECTOR: PROF. T. DALE), OF THE UNIVERSITY HOSPITAL, AND THE UNIVERSITY CLINIC OF PSYCHIATRY (DIRECTOR: PROF. G. LANGFELDT), OSLO, NORWAY

THIRD VENTRICLES OF 12 MM WIDTH OR MORE

A preliminary report

by

Arne Engeset and *Arve Lönnum*

In 1954 the authors reported the clinical and encephalographic findings in 50 cases of cerebral atrophy. In that material marked enlargement of the third ventricle and the anterior part of the lateral ventricle seemed to indicate a serious clinical condition. Thus 13 of 14 patients with a third ventricle measuring more than 9 mm in width were unable to work. The same applied to 12 of 15 patients with a lateral ventricle more than 20 mm in width, and to all 8 patients with a lateral ventricle measuring more than 25 mm. It was considered desirable to investigate whether a larger material would confirm the assumption that a relation exists between enlargement of the third and lateral ventricles and the degree of the patient's disabilities.

As the third ventricle appeared to be of special importance, the present study was based upon 100 patients from the neurologic, neurosurgical, and psychiatric centres of our hospitals with a third ventricle measuring 12 mm or more in width. This comparatively large measurement was chosen to avoid cases representing a normal variation.

Table 1

Average width of the third ventricle in 203 successive encephalographies arranged according to age groups

6—15 years	(25 cases)	.....	6.24
16—25 »	(31 »)	.....	7.00
26—35 »	(38 »)	.....	7.60
36—45 »	(44 »)	.....	8.60
46—55 »	(32 »)	.....	9.24
56—65 »	(24 »)	.....	11.20
66—75 »	(9 »)	.....	10.88

In this material there were 31 cases with a width of the third ventricle of more than 12 mm.

The average width of the third ventricle obtained in 203 previous successive encephalographies was found to be less than 12 mm (Table 1).

In applying LINDGREN's measurement of the frontal horn (1940) we found that 98 % of the cases were pathologic.

Cases of possible tumour or with increased intracranial pressure were not included.

The degree of incapacity for work was used as an indicator of the patient's condition. The width of the third ventricle was measured with air in the posterior part. Proper air-filling was obtained by tilting the head slightly forwards with the patient in the sitting position, the roentgen beam being directed at various angles to the horizontal plane through the third ventricle postero-anteriorly (Fig. 1).

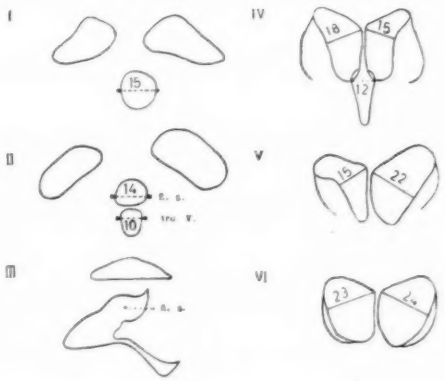


Fig. 1

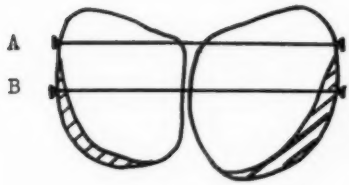
I — 3rd ventricle 15 mm in width with air in posterior part (p. a. view).

II — Great suprapineal recess (R. s.), 14 mm in p. a. view.

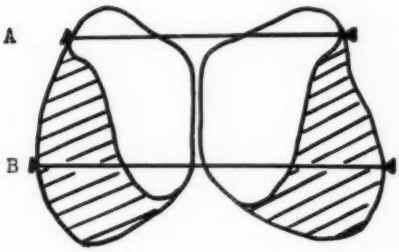
III — Suprapineal recess in the lateral view.

IV, V, and VI — Septum-caudate lines in different types of atrophy and a 3rd ventricle in the a. p. view. Measurements in millimeters.

The width of the anterior part of the lateral ventricle was estimated as follows (TROLAND et coll. 1946). The point at the apex of the angle between the septum pellucidum and the corpus callosum is



A: Cella media distance: 54 mm.
B: Frontal horn distance: 55 mm.
Difference: 1 mm.



A: Cella media distance: 50 mm.
B: Frontal horn distance: 66 mm.
Difference: 16 mm.

Fig. 2. The greatest width of the most anterior part of the frontal horns compared with the width of the two cellae media. A — Horizontal distance between the most lateral points of right and left cella media. B — Widest horizontal distance between the most lateral points of the anterior part of frontal horns (a. p. view).

more or less fixed near the midline. The distance from this point to the nearest point on the convexity of the caudate nucleus (or to a point at the bottom of an atrophic concave caudate nucleus) was used as an indicator of the width of the lateral ventricle, approximately between the anterior horn and the cella media. We call this distance the septum-caudate line. The determination of this measurement is a simple practical procedure which is easy to carry out (Fig. 1).

Results

The material consists of 80 males and 20 females. Seventy-five patients were over 45 years of age, the majority being in the 45 to 70 year age group. With an increasing size of the third ventricle the ages of the patients correspondingly increased. On the other hand the total number of cases decreased with an increasing size of the third ventricle, 80 per cent belonging to the 12 to 15 mm group. The rarity of cases in the 19 to 20 mm group (3 only) should be stressed.

A remarkably constant correlation was found between the width of the third ventricle and the average septum-caudate line (Diagram 1). The latter was calculated from 192 measurements of right and left lateral ventricles. When the third ventricle increased from 12 to 17 mm, the septum-caudate line increased from 17 to 24 mm bilaterally, the left being as a rule approximately 1 mm longer than the right.

Only 13 of 192 septum-caudate line measurements were found to be under 15 mm. This fact indicates that a short septum-caudate line is exceptional in the type of atrophy under consideration, *i. e.* central atrophy. Septum-caudate lines under 15 mm may furnish some information as to the normal length of the line, which will probably be less than the smal-

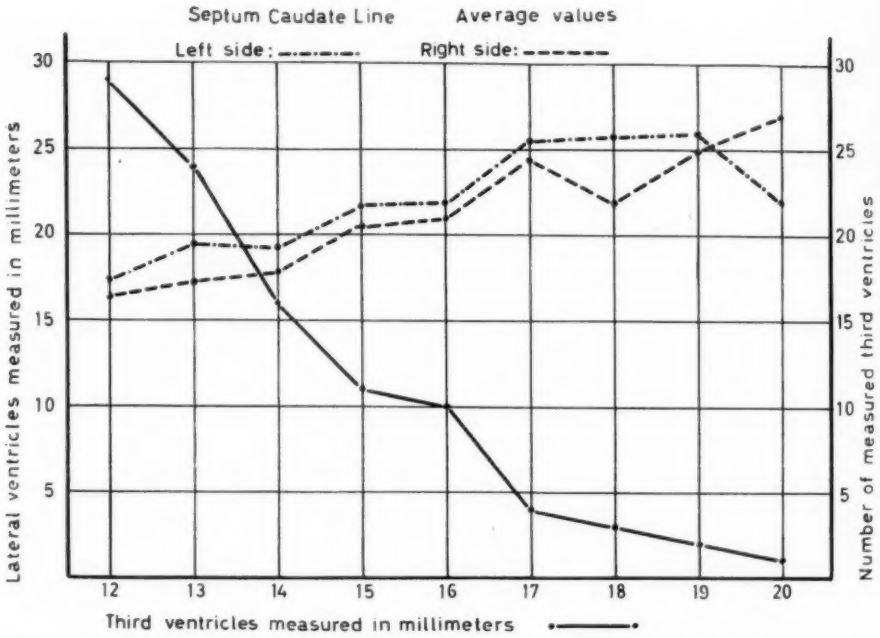


Diagram 1. Widths of 3rd ventricles arranged according to number of patients (unbroken line) and in relation to septum-caudate lines on the left and right sides, respectively. (The equal numbers on the left and right scales are purely incidental.)

lest size encountered in this material. Another indication may be afforded by cases disclosing asymmetry of the lateral ventricles : *e. g.* in a 62-year-old male the right septum-caudate line was 13 mm and the left 19 mm, which will probably mean that 13 mm is near the normal length in this age group.

The material has been divided into three groups based upon differences: 1) below 5 mm, 2) between 5 to 10 mm, and 3) more than 10 mm (Cf. Fig. 2). The larger differences as well as the smaller indicated a more serious clinical condition. In cases of Huntington's chorea the difference was found to be less than 5 mm. In cases of pseudopsychopathia the difference in most cases was found to be more than 10 mm.

When the various symptoms are correlated to the ventricular enlargement some show increasing frequency with increasing enlargement of the third and lateral ventricles (Table 2) while others present the opposite tendency (Table 3). A certain group of symptoms shows no definite correlation at all.

Table 2

Symptoms showing increasing frequency with increasing size of ventricles

Symptoms	Width of third ventricle in mm			Width of cella media in mm at septum-caudate line		
	12 to 13	14 to 15	> 16	< 20	20 to 25	> 25
Physical retardation	19	47	50	23	39	39
Psychical »	46	56	72	60	52	72
Physical exhaustibility	27	40	50	26	36	55
Psychical »	63	67	72	55	56	61
Emotional reduction	52	53	83	52	66	50
Reduced memory	70	75	88	76	77	61
Stereotypy	42	53	61	47	45	61
Care-taking problems	34	33	77	21	44	77
Reduced activities	42	40	70	47	52	38
Peculiar appearance	46	50	67	47	42	56
Circulatory disorders	46	50	67	47	54	56
Endocrine disturbances	48	40	67	45	39	79
Feeling of worthlessness	29	33	44	34	27	44
Epileptic seizures	40	47	55	42	48	67
EEG positive	55	56	67	42	66	72

Table 3

Symptoms showing decreasing frequency with increasing size of ventricles

Symptoms	Width of third ventricle in mm			Width of cella media in mm at septum-caudate line		
	12 to 13	14 to 15	> 16	< 20	20 to 25	> 25
Headache	65	40	18	63	47	50
Root pain, neuralgias	25	13	11	24	23	6
Diffuse pain paresthesias	38	43	16	37	42	22
Vertigo, dizziness, tinnitus	46	36	33	42	40	38
Nausea, vomiting	38	10	12	34	19	16
Anxiety	61	50	50	66	52	44
Difficulties at home	46	30	39	47	34	30
Pseudo-psychopathic behaviour	40	16	33	42	27	22
Feeling of guilt, remorse, self-accusation	33	30	17	32	27	22
Narcomania	40	16	16	30	22	22
Delusional ideas	25	10	16	24	20	7
Restlessness	67	43	44	63	57	33
Lability	77	67	62	70	72	72
Sleep disturbances	60	33	44	53	53	28

Table 4

Frequency of social problems

Care taking problems, 43 %:	
Nursing home cases	26
Completely helpless	24
Insane	10
Refusing food	4
Difficulties at home, 40 %:	
Personal conflicts	29
Economic problems	10
Wasting money	5
Withdrawal from social contact, 54 %:	
Seclusiveness	39
Reduced social contact for other reasons	49
Difficulties at the working place, 60 %:	
Working on sufferance	21
Instable workers	20
Other problems	44
Other problems, 29 %:	
Narcomania	15
Excessive use of drugs	20

Eighty-eight per cent of the patients in this material had completely lost their working capacity. Twelve patients claimed to have been at work until admission. Enquiry disclosed the fact, however, that as a rule the working capacity of these patients was also greatly reduced; they often did quite well some days while on others they failed almost completely. Reports of illness for shorter or longer periods were frequently noted. Almost all patients had serious social problems (see Table 4). The main cause of incapacity for work was psychic disturbances. In many cases, however, disturbances of consciousness, gait, coordination, and motility played a role, as did cephalalgia and other pain. Disturbances of the vegetative and endocrine apparatus often added significant symptoms. The present material therefore confirms the assumption that marked simultaneous enlargement of the third and lateral ventricles leads to severe loss of function and ultimately to incapacity for work.

As regards the causes of central cerebral atrophy, asymmetric cases deserve attention. We studied cases with greater differences than 2 mm in the left and right septum-caudate lines. Thirty-seven patients belonged to the asymmetric group, the asymmetry varying from 2 to 12 mm. The greater asymmetries were found in patients in whom a specific etiology was demonstrable (*e. g.* head trauma, leukemia, cerebral tuberculosis, etc).

SUMMARY

A method is described for the measurement of the enlargement of the central parts of the ventricular system. A correlation between the clinical condition and the enlargement of the third and lateral ventricles has been obtained.

ZUSAMMENFASSUNG

Eine Methode, die Vergrösserung der zentralen Abschnitte des Ventrikelsystemes zu messen, wird eingeführt. Eine Beziehung zwischen dem klinischen Bilde und der Vergrösserung des dritten Ventrikels und der Seitenventrikel wird demonstriert.

RÉSUMÉ

Les auteurs présentent une méthode de mesure de l'augmentation des dimensions des parties centrales du système ventriculaire et ont mis en évidence une corrélation entre l'état clinique et la dilatation du troisième ventricule et des ventricules latéraux.

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AUS DER NEUROLOGISCHEN KLINIK DER PALACKÝ UNIVERSITÄT IN OLOMOUC (VORSTAND: PROF. DR. J. HRBEK), TSCHECHOSLOWAKEI

BEITRAG ZUR PNEUMOGRAPHISCHEN DIAGNOSTIK DER EPIPHYSENTUMOREN

von

Edmund Klaus

Das pneumographische Bild der Tumoren der Pinealis-Gegend, insbesonders der Epiphysentumoren, wird als charakteristisch bezeichnet. Kurz wiederholen wir: ein meist glattwandiger ventralkonvexer Füllungsdefekt in der hinteren Kontur des 3. Hirnventrikels, baldige Obliteration des Recessus suprapinealis, eventuell Entstehung eines Pseudorecessus, Ventraldislokation der 3. Hirnkammer, Basalverschiebung und meistens frühzeitige Abklemmung des supratentoriellen Aquäduktsabschnittes, Dilatation der Seitenkammer und des Restes des 3. Ventrikels und schliesslich ein grösserer Abstand zwischen den hinteren Partien der 3. Hirnkammer und vorhandener Pinealisverkalkung.

Die Voraussetzung für eine richtige Interpretation der Luftencephalogramme der Pinealisgegend ist eine genaue Kenntnis der normalen, physiologisch sehr wechselhaften anatomo-pneumographischen Verhältnisse. Aus diesem Grunde unterzogen wir 200 regelmässige Pneumoencephalogramme einer genauen Kontrolle. Alle wurden lumbal vorgenommen und am Lysholmtisch (mit einer Focusdistanz von 75 cm) untersucht. Das Alter der Patienten bewegte sich zwischen 15 und 70 Jahren, mit der grössten Anzahl zwischen 25 und 40 Jahren.

Wir kamen bei kritischer Betrachtung zu folgenden Ergebnissen: die dorsalen Partien des 3. Ventrikels erscheinen als die den meisten physiologischen Varianten unterliegenden Segmente der inneren Liquorräume. In dieser Hinsicht führt der Recessus suprapinealis, nicht nur in der Varia-

bilität seiner Länge und Form, sondern auch in seinem Verlauf. In unserer Serie ist er im Durchschnitt 10 mm lang, maximal 22 mm, minimal vollkommend fehlend. Hier wollen wir darauf aufmerksam machen, dass sich der Recess manchmal erst bei wiederholter Projektion abbildet, insbesonders dann, wenn sein Verlauf gegenüber der oberen Ventrikelkontur abschüssig ist und so seine Luftfüllung erschwert ist. Am breitesten ist die obere Vorstülpung an der Basis, durchschnittlich 4.5 mm, maximal 13 mm, minimal 2 mm. Sein Verlauf ist im allgemeinen ziemlich konstant, meistens parallel zum supratentoriellen Abschnitt des Aquädukts. Manchmal ist das aborale Recessende, insbesonders beim Megarecessus, nach oben abgeknickt. Der Recessus suprapinealis hat entweder zylinderförmige oder trichterförmige Konfiguration, manchmal ist er aboral konisch. Die 2., distal vom Recessus suprapinealis liegende Vorstülpung — der Recessus pinealis, besser infrapinealis — überschreitet in unserem Material nicht die Länge von 3 mm und hat ungefähr dreieckiges Aussehen in seitlicher Darstellung. Auch der Verlauf der hintern Kontur der 3. Hirnkammer in lateraler Projektion variiert, im allgemeinen steht sie etwas schief nach vorn, mit leicht welligem Verlauf, manchmal verläuft sie senkrecht und zweimal in unserem Material wies sie eine scharfrandige, gleichmässig ventralkonvexe Konfiguration auf, welche einem Füllungsdefekt wie bei Pinealistumoren sehr ähnelte.

Auf allen unseren normalen Pneumoencephalogrammen beobachteten wir, dass auf Seitenaufnahmen sehr anschauend eine konstante Entfernung zwischen der Hinterwand der 3. Hirnkammer und dem charakteristischen Luftbild der Cisterna ambiens besteht, welche regelmässig in fast gleicher Höhe wie diese liegt. Wir wollen diesen Abstand Ventrikel—Zisternen-Distanz bezeichnen. Wir bestimmen sie durch eine kürzeste Verbindungslinie zwischen dem ungefähren Mittelpunkt (am meisten dorsal gelegener Punkt) der charakteristisch dorsalkonvex gebogenen Luftstreifen der Cisterna ambiens und dem korrespondierenden Mittelpunkt der Ventrikelhinterwand. In unserem normalen Material, wo die Zisternen beider Seiten exakt aufeinanderprojiziert sind, oder sich zumindestens knapp parallel nebeneinander präsentieren, beträgt dieser Abstand im Durchschnitt 9.6 mm (Abb. 1a), mit einer Streuweite maximal bis 14 mm und minimal 6 mm, wobei die Zisterne immer die vordere oder mittlere Partie der Vierhügelgegend überbrückt. Bei Dilatationen der 3. Hirnkammer kommt es im allgemeinen zu einer dorsalkonvexen Ausbuchtung der Hinterwand und zu einer Annäherung in Richtung Cisterna ambiens. Die Ventrikel—Zisternen-Distanz verkürzt sich, bei unseren 7 mittelweiten bis grossen Dilatationen betrug sie weniger als 6 mm, zwischen 5 bis 3 mm (Abb. 1b). Die Basis des Recessus suprapinealis ist dilatiert, der Recessus erscheint plump, der untere Recess wird verwischt.

Vergegenwärtigen wir uns anatomo-pathologisch die Lage der Tumo-

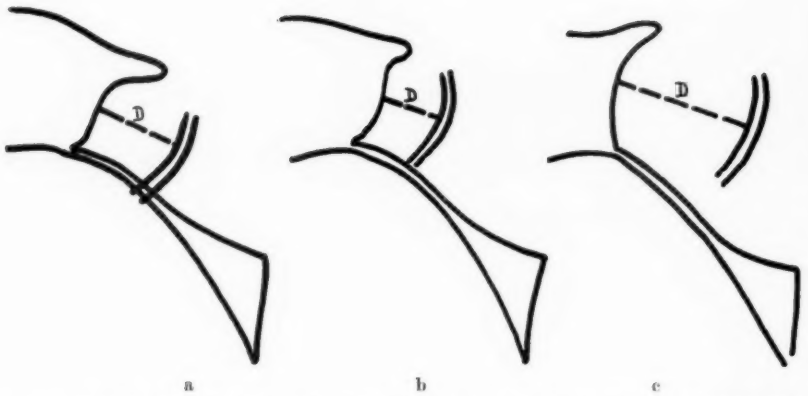

Abb. 1. a) Normale Distanz 3. Ventrikel — Cisterna ambiens (7 bis 14 mm). b) Verkürzte Distanz bei Erweiterung der 3. Ventrikel (weniger als 6 mm). c) Pathologische Erweiterung der Ventrikel—Zisternen-Distanz bei Pinealistumoren (grösser als 16 mm).

ren der Pinealisgegend, so liegt es auf der Hand, dass es zu einer Erweiterung dieser Ventrikel—Zisternen-Distanz kommen muss, und zwar durch Ventralverschiebung und Amputation der hinteren Partien der 3. Hirnkammer bei unveränderter Lage der Cisterna ambiens. Diese theoretische Ueberlegung konnten wir an unserem pneumographischen Material von Pinealistumoren beglaubigen und ein radiopathologisches Zeichen dieser Geschwülste, insbesonders im Anfangsstadium, herausarbeiten.

Bei Pinealistumoren beobachteten wir also eine sichtliche, messbare Vergrösserung dieses konstanten Ventrikel—Zisternen-Abstandes, der sich bei unseren Epiphysentumoren zwischen 19 und 27 mm bewegte (Abb. 1c).

Zwei praktische Beispiele werden in Abb. 2 illustriert. Abb. 2a zeigt ein Pinealom bei einer 35-jährigen Frau; scharf konturierter Defekt der hinteren Kontur des 3. Ventrikels, Ventrikel—Zisternen-Distanz 19 mm. Abb. 2b zeigt ein Pinealom bei einem 17-jährigen Knabe; Kammer—Zisternen-Distanz 27 mm. Diese pathologische Erweiterung war die grösste bei noch durchgängigem Aquädukt.

Unserer Meinung nach erweist sich dieses radiopathologische Symptom als praktisch, insbesonders in der Diagnostik kleinerer Geschwülste der Pinealisgegend, bevor der Aquädukt am Ausgang aus der 3. Kammer abgeklemmt ist. In diesen Fällen kann man sich der Pneumoencephalographie bedienen und muss nicht zur Ventrikelpunktion schreiten. Bei der lumbalen Luftfüllung ist es selbstverständlich notwendig, nebst der Ventrikelfüllung auch eine Füllung der Zisternen vorzunehmen, was fast immer bei Nachspritzung von 5 bis 10 ml Luft in forcierter Kopf-

a b

Abb. 2. a) Pinealom. Distanz 3. Ventrikel — Cisterna ambiens 19 mm. b) Pinealom. Distanz 3. Ventrikel — Cisterna ambiens 27 mm.

beugung gelingt. So erzielten wir immer, vorausgesetzt, dass der Aquädukt durchgängig ist, eine zufriedenstellende Füllung der 3. Hirnkammer sowie der Cisterna ambiens. Dort, wo man wegen Aquäduktstenose die Luftfüllung durch direkte Punktion der Hirnkammer durchführen muss, empfielt es sich diese mit lumbaler Cisternographie vorteilhaft zu vervollständigen. Dieses pneumo-pathologische Zeichen erweist sich als praktisch und vorteilhaft, insbesonders dann, wenn Zweifel entstehen, ob es sich um einen wirklichen Füllungsdefekt in den hinteren Partien der 3. Hirnkammer handelt. Wir wollen hier nochmals darauf hinweisen, dass in 2 normalen Encephalogrammen die hintere Kammerkontur einem wirklichen Füllungsdefekt sehr ähnelte, die Ventrikel—Zisternen-Distanz bewegte sich aber in physiologischen Grenzen und schloss einen pathologischen Befund aus. Ganz besonders für weniger Geübte halten wir das pathologische Auseinanderrücken der dorsalen Ventrikelpartien von der Cisterna ambiens für gut brauchbar.

Abschliessend wollen wir kurz zusammenfassen, dass wir eine Ventrikel—Zisternen-Distanz, welche grösser als 14 mm ist, für suspekt pathologisch halten und Werte, wie in unserem Tumormaterial, also grössere Distanzen als 18 mm, als charakteristisch für Geschwülste der Pinealisgegend betrachten. Es liegt auf der Hand, dass Pinealistumoren, welche sich weniger gegen den Aquädukt hin ausbreiten, also später zu seiner Abklemmung führen, grössere Distanzwerte aufweisen können,

als Tumoren, welche durch basale Wucherung sehr früh den Aquädukt obturieren und deshalb bei lumbaler Füllung nur kleinere Messwerte aufweisen werden.

Schliesslich müssen wir mögliche Dislokationen der Cisterna ambiens bei Herniationen und Verschiebungen der 3. Hirnkammer bei Tumoren der hinteren Schädelgrube im Auge behalten, was aber in differentialdiagnostischer Hinsicht keine grösseren Schwierigkeiten bereitet.

ZUSAMMENFASSUNG

Der Verfasser berichtet über ein neues pneumo- pathologisches Zeichen bei Tumoren der Pinealisgegend. Er führt d. sog. Ventrikel- Zisternen-Distanz ein, d. i. die lineare kürzeste Entfernung zwischen der dorsalen Kontur der 3. Hirnkammer und der Cisterna ambiens in Seitenaufnahme. Bei Tumoren der Pinealisgegend kommt es zu einer sichtlichen, mehr als 15 mm messenden Dilatation dieses Abstandes.

SUMMARY

The author describes a new pneumo-pathologic sign of a tumour in the region of the pineal body. He introduces a "ventricle-cistern" measurement, one which represents the shortest distance between the posterior margin of the third ventricle and the ambient cistern as seen in the lateral view. This is appreciably increased, by more than 15 mm in cases of a tumour in the pineal region.

RÉSUMÉ

L'auteur décrit un nouveau signe pneumo-encéphalographique de tumeur de la région pinéale. Il propose une mesure "ventriculo-cisternale", qui représente la plus courte distance entre le bord postérieur du troisième ventricule et la citerne ambiante, vus sur la radiographie de profil. Cette distance est notablement augmentée, supérieure à 15 mm dans les cas de tumeur de la région pinéale.

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FROM THE MONTREAL NEUROLOGICAL INSTITUTE, MONTREAL, CANADA

PNEUMOGRAPHIC FINDINGS IN ANGIOMATA OF THE BRAIN

by

D. L. McRae and *V. Valentino*

Angiography is the most reliable method of diagnosing intracranial angiomata in the intact patient. Since the clinical picture is not always typical these patients are often suspected of having other lesions of the brain and may be investigated by pneumography, especially in those centers in which air studies are preferred to arteriography. The pneumographic findings in intracranial angiomata are not typical either. They vary with the site and extent of the lesion as well as with the presence or absence of secondary pathologic changes in the brain. The mass of angiomatous vessels may act like a space-occupying lesion producing displacement with or without deformity of the ventricles. Ventricular obstruction may occur if the lesion interferes with the cerebro-spinal fluid circulation. Intracranial hemorrhages may also occur. Focal or generalized atrophy are frequently found. The different pneumographic patterns may be combined in various ways.

This paper is based on thirty-five cases of intracranial angiomata studied by pneumography. The cases in which the diagnosis was not confirmed by angiography had surgical and/or pathological confirmation.

A summary of the main pneumographic findings is given below:

Pneumographic changes in 35 cases of intracranial angiomata

	Number
Normal	2
Pathologic changes (in 33 cases):	
Interference with the cerebro-spinal fluid circulation	6
Space-occupying lesions:	
without intracranial hemorrhage	3
with intracranial hemorrhage	3
Signs of focal or generalized atrophy	12
Combined signs of space-occupying and atrophic lesions	7
Abnormality of the subarachnoid sulci	2

Angiomata interfering with the cerebro-spinal fluid circulation

Our series includes: 1) three cases of angioma of the midbrain, 2) two cases of arteriovenous aneurysm of the great vein of Galen, and 3) a case of vascular malformation involving most of the left cerebral hemisphere.

1. Angiomata of the midbrain. This area seems to be a common site of vascular malformation. The quadrigeminal plate is supplied by a particularly rich anastomotic network of arteries. In our three cases of angioma of the midbrain the lesion was seen to involve chiefly the quadrigeminal plate. Hydrocephalus due to obstruction of the aqueduct of Sylvius is in our experience the essential and constant feature revealed by pneumography. The hydrocephalus may or may not be combined with some deformity of the posterior aspect of the third ventricle due to the protrusion into it of the abnormal vessels. The obstruction of the aqueduct may be slowly progressive or it may occur suddenly. Although direct pressure by the angiomatous mass upon the aqueduct can play a part, a reactive peri-aqueductal gliosis secondary to small episodes of bleeding seems most likely to be the cause of the obstruction.

2. Arteriovenous aneurysms of the great vein of Galen. This term should be related to arteriovenous shunts with increased flow of blood in the great vein of Galen, so that it is transformed into a large sac. The great vein of Galen can become very large and in its expansion press on the adjacent aqueduct and the posterior wall of the third ventricle so that obstructive hydrocephalus results (Fig. 1).

Small episodes of bleeding seem to be less frequent and degenerative gliosis in the peri-aqueductal area are not so remarkable as in cirsoid angiomas of the quadrigeminal plate. This might account for the fact that stenosis of the aqueduct is usually not total in aneurysms of the great vein of Galen. The pneumographic abnormalities seem to result more from the expansion of the great vein than from secondary changes in the adjacent brain. The anterior displacement of the postero-superior aspect of the

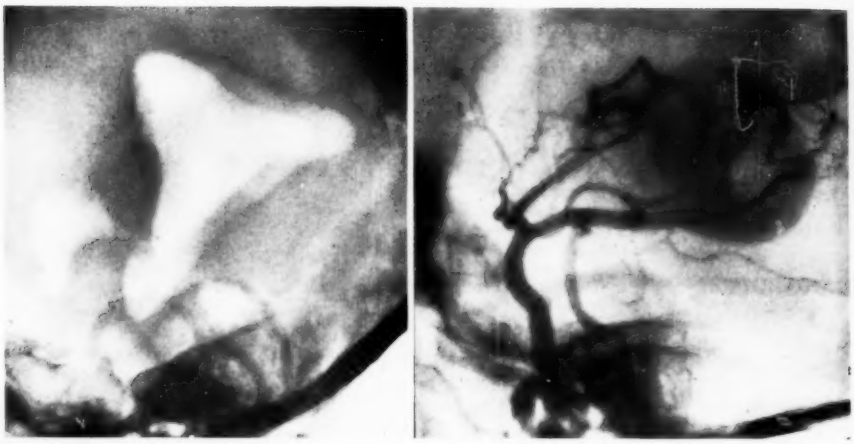

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Fig. 1. Case T. M., male, age 3 months. The mother complained of the baby's head slowly enlarging since birth. a) Lateral ventriculogram with the patient prone. Dilated lateral and third ventricles. Smooth curved indentation of the posterior part of the roof of the third ventricle. b) Carotid arteriogram. Filling of the carotid and vertebral arteries and their branches. Large saccular aneurysm of the great vein of Galen.

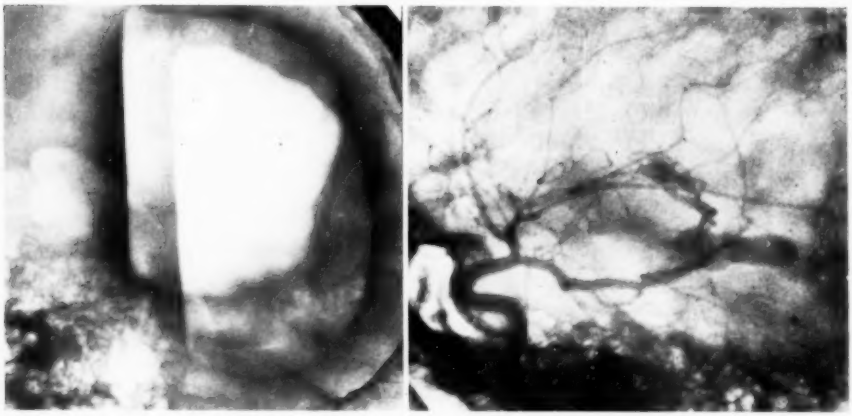

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Fig. 2. Case L. S., female, age 13 years, complained of sudden right hemiplegia. a) Lateral ventriculogram with the patient prone. Hydrocephalus of the lateral and third ventricles and almost complete closure of the aqueduct due to an aneurysm of the great vein of Galen. b) Carotid arteriogram. Filling of an enlarged vein of Galen during the arterial phase.

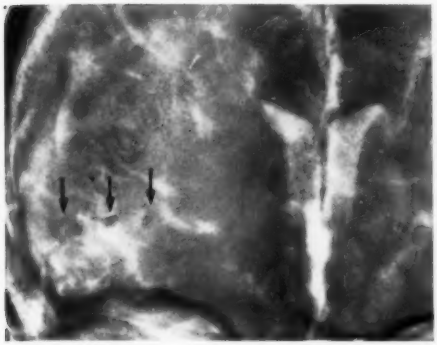

Fig. 3. Case I. I., female, age 30, complained of recurrent epileptic seizures since age 2 years. A. p. encephalogram suggesting an expanding lesion of small size on the right side in the region of a pathological calcification at the posterior end of the Sylvian fissure.

third ventricle is entirely due to the compression exerted on it. The bigger the aneurysm the more remarkable the bulge but it can be wholly lacking in some cases (Fig. 2).

3. Cortical angiomas. Interference with the cerebro-spinal fluid pathway by cortical angiomata is rare. Occasionally it may occur if the lesion extends deeply to reach the ventricular cavities. In our material there is one case with a tremendous malformation involving the left cerebral hemisphere. In this case a partial obstruction of the foramen of Monro on the left side was probably present. At encephalography and also at ventriculography performed by injection of air into the right ventricle gas did not enter the left ventricle. It seems reasonable to assume that in such instances the partial obstruction of the foramen of Monro is caused either by an enlarged choroid plexus and/or by enlargement of the veins, chiefly the strio-thalamic vein.

Angiomata mimicking space-occupying lesions

A distinction must be drawn in this group between angiomata which are combined with encapsulated blood clots and angiomata which are not.

Angiomata without intracranial hemorrhage. There were three patients with cerebral angiomata in whom there were pneumographic signs suggesting a space-occupying lesion and in whom there was no history to suggest an intracranial hemorrhage and in whom no hematoma was found at operation. The encephalogram suggested that the space-occupying lesion was small in two cases and medium in size in the third case. In one case (Fig. 3), there was pathological calcification in the angioma and in another there was a curious large vessel groove in the temporal squama on the side of the lesion. Today we would have suggested angioma on the basis of the findings on the conventional skull films and angiography would have been carried out.

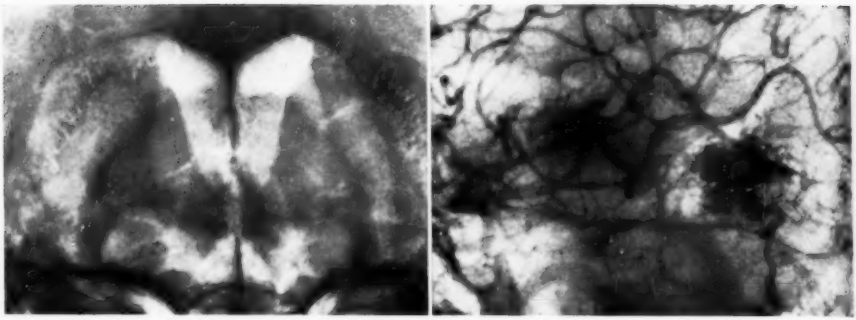

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Fig. 4. Case M. M., male, age 20 years, complained of epileptic seizures for eight months. a) A. p. encephalogram showing local enlargement of the trigone of the right lateral ventricle due to an arteriovenous angioma of the posterior part of the right temporal lobe. b) Right carotid arteriogram.

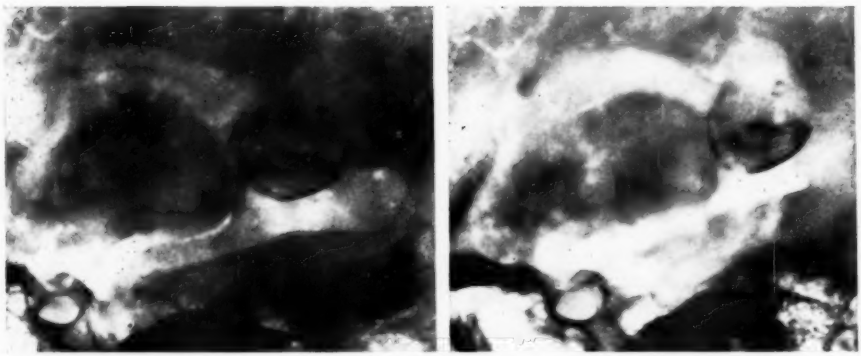

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Fig. 5. Case Y. N., female, age 24 years, complained of seizures for four years beginning with auditory and visual hallucinations. Right and left lateral encephalograms. Enlargement of the left temporal horn (a) and generalized enlargement of the two lateral ventricles of moderate degree (b). Calcified posterior temporal angioma on the left side.

Angiomata with intracranial hemorrhage. Intracranial bleeding with formation of a large blood clot sometimes organized at the periphery and encapsulated is not infrequent in angiomata. Obviously a large blood clot in the brain acts as a space-occupying lesion. In such cases, the pneumographic findings depend exclusively on the location and size of the blood

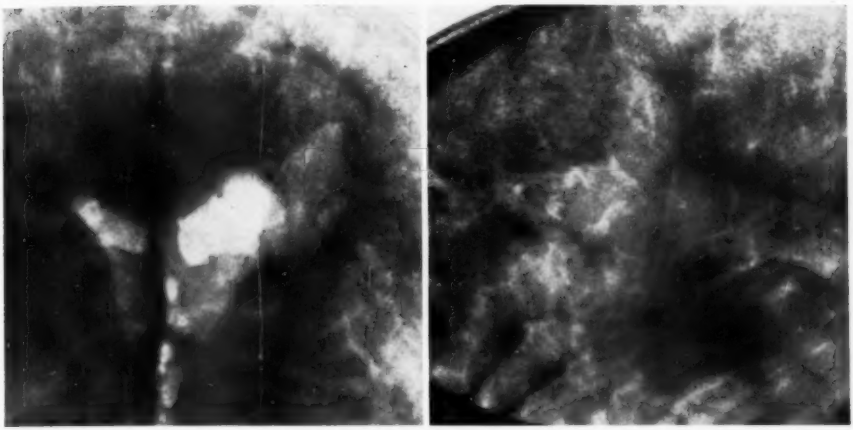

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Fig. 6. Case W. O., male, age 22 years, complained of epileptic seizures for five years. a) A. p. and b) lateral encephalograms showing enlargement of the entire left lateral ventricle and a diverticulum coming from the antero-superior part of the body of the left lateral ventricle. A large arteriovenous angioma of the left Rolandic region was found at operation.

clot and are similar to those produced by tumors. Mistaking the lesion for a brain tumor may be unavoidable if the history is not that of a sudden vascular accident. There is in our material a 64-year-old woman who complained of episodic headache and speech difficulty of nineteen years duration. This patient had been supposed to be suffering from arteriosclerosis, but after investigation she was operated on with removal of a large encapsulated hematoma from the left temporal lobe due to an angiomatous malformation.

Angiomata causing signs of focal or generalized atrophy

This is the largest group in our series. The atrophy may be due to either nutritional deficiency of the peri-angiomatous neural tissue or to small multiple areas of hemorrhagic degeneration and necrosis. The process may involve a single area and remain well circumscribed or it may be diffuse involving one whole cerebral hemisphere. Therefore different pneumographic changes are seen (see for instance Fig. 4). Sometimes focal and generalized atrophy are found together, that is, the ventricle on the side of the lesion is dilated in all portions but the enlargement is definitely greater at the site of the angioma (Fig. 5). Occasionally owing to erosion of the ventricular walls secondary to hemorrhagic degeneration, the area

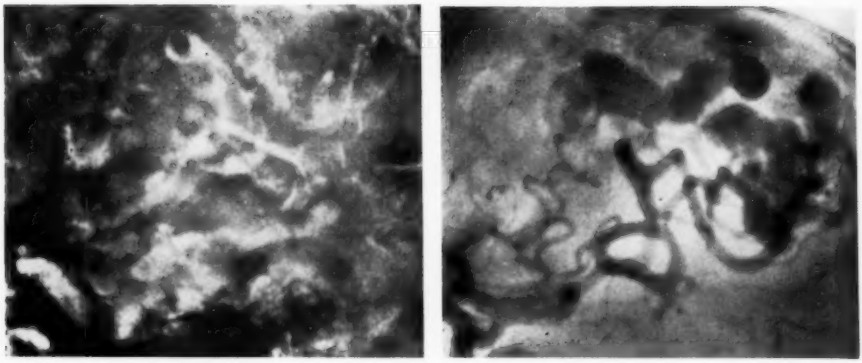

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Fig. 7. Case J. T., male, age 51 years, complained of slight right hemiparesis for all of his life and one recent epileptic seizure. a) Lateral encephalogram, showing enlarged blood vessels on the left lateral surface of the brain outlined by gas. b) Right carotid arteriogram showing an arteriovenous angioma in the left Rolandic region. The large vein that was surrounded by gas in the encephalogram is clearly visible.

of necrosis may communicate with the adjacent ventricle, forming a diverticulum (Fig. 6). The atrophy of the peri-angiomatous tissue may be so great as to obscure partially some other signs of space-occupying lesion when the latter occur, for example in cases of associated intracerebral hemorrhage.

Angiomata causing combined signs of space-occupying and atrophic lesions

Not infrequently, radiological findings of atrophy of the cerebral tissue are combined with signs of an intracranial space-occupying lesion. This occurs when the angioma is so large as to displace the ventricles towards the opposite side while in the same patient there is atrophy of the homolateral hemisphere with enlargement of the homolateral ventricle.

Angiomata causing abnormality of the subarachnoid sulci

An abnormal appearance of the subarachnoid sulci at encephalography is not uncommon in cortical angiomata. Such abnormalities include either non-filling of the subarachnoid sulci at the site of the lesion or abnormally large sulci at the site of the lesion. Unfortunately, asymmetry of the sulci at encephalography may be seen in some normal patients, therefore the

limits beyond which asymmetry should be considered abnormal are very difficult to establish. For this reason, we do not mention five cases in which slight abnormality of the subarachnoid sulci was noted. In those five cases the questionable sulci did not represent the main pneumographic findings, there being definite changes in the ventricles. In one of the two striking cases of abnormal sulci the subarachnoid sulci were so irregularly and characteristically arranged in the area of the angioma as to give a good idea of gas encircling individual blood vessels. The appearance of the sulci in this patient as ring-like and double-contoured shadows in the area of the malformation constituted the only pathological change revealed by pneumography (Fig. 7).

Conclusions

An abnormal pneumogram is not uncommon in angiomata of the brain. Among our thirty-five cases only two patients had a completely normal pneumogram. The pathological features are different in cortical and central angiomata. In the latter, interference with the cerebro-spinal fluid circulation and obstructive hydrocephalus are fairly common. Occasionally the bulging of the abnormal blood vessels within the adjacent ventricular cavities gives rise to a pattern which simulates a space-occupying lesion. In cortical angiomata the commonest pneumographic features are those connected with atrophy of the adjacent brain. Combined findings of atrophic and space-occupying lesions as well as of space-occupying lesions alone may also occur. It is worth while noting that the pneumographic appearance of a space-occupying lesion can be present without the association of a circumscribed hematoma. Diverticulae of the ventricles as well as striking abnormalities of the subarachnoid sulci are rare but do occur.

The pneumographic findings are chiefly due to:

1. The extent and location of the malformation;
2. The atrophy and the gliosis in the adjacent brain, which each may give rise to opposite types of pneumographic appearances, atrophy producing enlargement of the ventricular cavities while gliosis may be of a proliferative type and so great as to act as a space-occupying lesion;
3. Encapsulated blood clots;
4. Perforation of the ventricular wall subsequent to hemorrhagic necrosis.

Acknowledgement

For the years 1956—1957 one of the authors (V. V.) was the holder of a James Picker Foundation Fellowship in radiological research.

SUMMARY

The pneumographic findings in 35 cases of intracranial angiomata are discussed. The authors have found that an abnormal pneumogram is not uncommon with these lesions. Only in 2 cases was the pneumogram normal.

ZUSAMMENFASSUNG

Die pneumographischen Befunde in 35 Fällen mit intrakraniellen Gliomen werden besprochen. Die Verfasser haben gefunden, dass ein abnormes Pneumogramm bei diesen Tumoren nicht ungewöhnlich ist. Nur in 2 Fällen lag ein normaler Befund vor.

RÉSUMÉ

Les auteurs examinent les signes pneumo-encéphalographiques trouvés dans 35 cas d'angiomes intracraniens et constatent qu'il n'est pas rare que la pneumo-encéphalographie soit anormale dans cette affection. La pneumo-encéphalographie n'a été normale que dans deux de leurs cas.

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DYNAMIC ENCEPHALOGRAPHY

A report of two years' experiences

by

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The original encephalographic procedure was introduced by DANDY in 1919 and modified by LINDGREN in 1949. A third method, the 'dynamic' method was first employed by one of us in 1954 (PALMA 1955) and appears to present several advantages over the earlier methods; it has so far been used in 135 cases with good results.

Dandy's method. Air in a total amount of 100 to 200 ml are injected by lumbar puncture, care being taken that the volume injected does not exceed that of the cerebrospinal fluid removed. Ten milliliters of the cerebrospinal fluid are first removed and 5 ml of air injected; further fluid, 5 ml at a time, is thereafter removed and replaced by equal volumes of air. All the cerebrospinal fluid, if necessary, may be removed. According to DAVIDOFF and DYKE, the injection of 50 to 70 ml of air is sufficient to fill the ventricles and subarachnoid spaces; if this amount is exceeded, the gas will occupy the spinal subarachnoid space. The more gas injected, the greater is the intensity and duration of the meningeal reaction.

Dandy's lumbar puncture method has been used by many authors but the same technique, with the employment of the cisternal route, much less. Nevertheless, SCHAEFFER (1929), FLÜGEL (1930), YOUNG (1941), and others, consider it to be preferable as it is simpler and requires a smaller volume of gas.

With either of these routes, it has been generally considered that encephalography is contra-indicated if cranial hypertension whatever its degree exists and should be replaced by ventriculography.

Lindgren's method. LINDGREN uses lumbar puncture, but contrary to the general view, insists that the total volume of air injected should always be greater than that of the fluid removed, and that the air must be injected before removing the fluid. This method necessitates the injection of 15 to 20 ml of air to demonstrate the ventricles, and 10 ml to outline the cisterns. This volume of air is injected slowly, 5 to 10 ml at a time, each injection being followed by the removal of 4 to 8 ml of fluid. When slight hypertension exists, the total volume of air injected varies from 5 to 10 ml and no fluid is removed. The position of the patient's head must be varied during the procedure in order to demonstrate successively the third and fourth ventricles and the posterior and anterior cisterns.

Lindgren's method is superior to Dandy's and better than ventriculography for the investigation of the posterior fossa and the diagnosis of its expanding lesions. It is also useful for the study of lesions situated between the middle and posterior fossae. The method has been used successfully by FALK (1953, 1956), WICKBOM & SHELDON (1953), RUGGIERO (1953), RUGGIERO et coll. (1953, 1954), and others.

Authors' method: 'dynamic' encephalography. The authors have used cisternal puncture and the injection of oxygen as a routine measure for some time. Oxygen appears to be less irritating and is more easily absorbed than air. Films are obtained while the gas is still moving upwards, and before it has accumulated superiorly. Any excess of gas or liquid is allowed to escape. Because of these two factors the method is called 'dynamic' encephalography.

During the injection the oxygen rises through the central ventricles but, as it cannot pass upwards through the aqueduct of Sylvius as fast as it is injected it also fills the basal cisterns; if the passage of the gas through the aqueduct is completely blocked, it immediately escapes — together with fluid — through the needle. In order clearly to demonstrate the third and fourth ventricles and the cisterns of the posterior fossa, 10 ml of oxygen in children, and 20 ml in adults, are injected for every film. Half this volume of cerebrospinal fluid is previously

Fig. 1. Schematic illustration of cisternal puncture. a) Normal case. The a. p. dimension of the cisterna magna is maintained and the needle can advance freely between the tonsils for several millimeters without touching the medulla. b) Cases presenting hypertension and moderate cerebellar herniation within the cisterna magna. The herniated vermis and tonsils occupy part of the cistern. The needle meets the tonsils or the vermis shortly after penetrating the cistern. c) Cases with extreme hypertension and large herniation within the cisterna magna. The vermis and tonsils occupy nearly the whole cistern. The needle meets the vermis or the tonsils immediately after entering the cisterna magna.

removed. If necessary, two or three serial films may be obtained at each injection.

Dynamic encephalography may be used in most cases of cranial hypertension. It is only contra-indicated in severe hypertension, especially when there is a danger of tentorial herniation. One of us (E. P.) has tried to avoid this risk by the introduction of a catheter into the right lateral ventricle prior to the cisternal puncture.

As is the case with Lindgren's method, the dynamic technique appears to be most useful for the diagnosis of pathologic processes in the posterior fossa and of expanding lesions of the diencephalon, brain-stem, and hypophysis. It appears, however, to present several advantages over Lindgren's method. It is better tolerated, is less risky when hypertension exists, and is simpler and quicker to perform. The head is not moved during the procedure, and two films are usually sufficient to study the posterior fossa, instead of the six or more required in Lindgren's method. Cisternal puncture, with the needle directed obliquely forwards and upwards, carries the tip of the needle into the cisterna magna on a level with or above the upper edge of the occipital foramen and between the tonsils. This puncture has the following advantages. The pressure of the cerebrospinal fluid in the posterior fossa may be measured. An approximate idea of the antero-posterior dimension of the cisterna magna may be obtained (Fig. 1) by observing the distance the needle advances from the moment the dura mater is pierced and fluid begins to flow, until the moment it ceases, due to contact of the tip of the needle with the brain; the needle must be pushed forwards very slowly, millimeter by millimeter. In most cases it will suffice if this dimension of the cisterna magna is 4 or 5 millimeters. When there is high intracranial pressure with

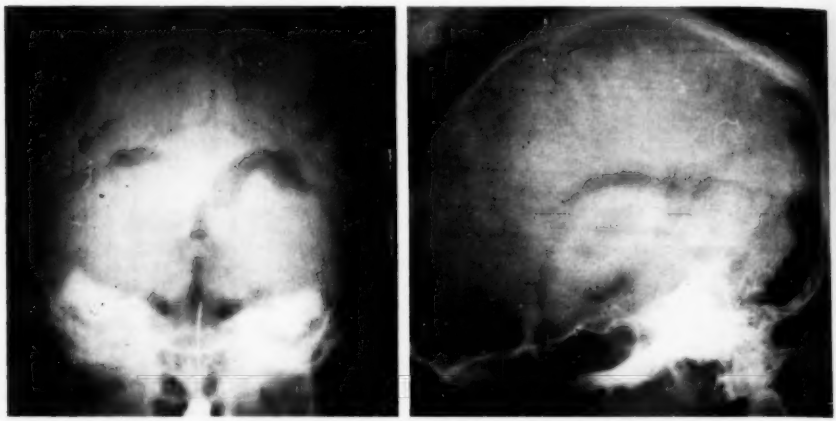

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Fig. 2. a) Normal dynamic lateral encephalography (p. a.), showing shape, size and position of third and fourth ventricles, aqueduct, cisterna magna and ponto-cerebellar, quadrigeminal and ambient cisterns. b) Normal dynamic encephalography (lateral) showing third and fourth ventricles, aqueduct, caudal portion of the lateral ventricles and the chiasmatic, interpeduncular, ambient cisterns and cisterna magna.

herniation the tonsils herniate into the cisterna magna, the needle meets the vermis of the tonsils, and the cerebrospinal fluid ceases to escape before the tip of the needle reaches the medulla, which forms the anterior wall of the cisterna magna.

The removal of cerebrospinal fluid takes place in the cisterna magna above the occipital foramen, and the danger of impaction of the tonsils in this bony ring is avoided. The inferior pole of the tonsils lies below the tip of the needle and even more definitely so when hypertension exists. If fluid is removed from the cisterna magna and gas injected, a momentary fluid level is obtained at the upper margin of the occipital foramen, while the inferior pole of the tonsils continues to float in the cerebrospinal fluid.

Cranial hypertension, resulting from or increased by the injection of a volume of gas greater than that of the fluid removed, fails to produce impaction of the tonsils in the occipital foramen. This is due to the following factors: the short duration of the hypertension, because the needle used for the injection allows gas and/or fluid to escape immediately, to the fact that the tonsils float, and that the decompression takes place at or above the upper margin of the occipital foramen.

Before escaping or accumulating superiorly on its way upwards, the gas fills the third and fourth ventricles and the cisterns of the posterior

Fig. 3. Dynamic encephalography (p. a.) in an abscess of left cerebellar hemisphere showing the fourth ventricle deformed, the aqueduct dilated and both displaced to the right. Left cerebello-pontine cistern and lower half of the ambient cistern both obliterated.

fossa. It is at this moment, and at the end of the injection, that the films should be exposed.

Incipient tentorial herniation may be aggravated by dynamic encephalography because of the drop in pressure within the posterior fossa, *i. e.* below the herniation, together with the increase in pressure above, resulting from the gas which enters the lateral ventricles. Even though the volume of fluid escaping from the cisterna magna through the needle is small, the drop in pressure is considerable and rapid when there is incipient tentorial herniation. In such cases a catheter is introduced into the anterior horn of the lateral ventricle (usually the right), before carrying out dynamic encephalography. Large differences of pressure between the cerebrospinal fluid above and below the tentorium are thus avoided as the catheter decompresses before the gas is injected. When the gas enters the posterior fossa, a corresponding volume of cerebrospinal fluid or gas escapes through the catheter.

Technique

The patient is placed in the sitting position and is held firmly with the head against the film holder. Following local anaesthesia with 1 % procain, cisternal puncture is carried out with a fine, short-bevel needle. The needle is introduced directly in the midline, just above the spinous process of the axis; it is then advanced forwards and upwards, close to the posterior margin of the occipital foramen, to enter the cisterna magna. The tip of the needle then lies at the level of the upper margin of the foramen. A reading is taken of the cerebrospinal fluid pressure within the cisterna magna, after which the needle is pushed carefully forwards for a few millimeters to determine the persistence and antero-posterior dimension of the cisterna magna at the midline.

Five to 10 ml of cerebrospinal fluid are now removed and double the volume of oxygen rapidly injected. These volumes are varied according to the age of the patient and the nature of the case. One or more films are obtained as soon as the gas has been injected. The syringe is then removed, the needle being left in position to allow the injected gas and/or cerebrospinal fluid to flow out from the cisterna magna; by this means the cranial hypertension caused by the injection, or increased by it, is quickly relieved.

The injection and films are repeated in various positions according to the needs of the case. A frontal view and a lateral view are usually taken and in certain cases

are supplemented by oblique views. Further routine films are then obtained in order to demonstrate the various parts of the lateral ventricles.

The technique described has been employed in 135 cases. In one case of extreme hypertension with incipient tentorial herniation and in which a catheter had not been placed in the lateral ventricle, transitory coma ensued with no further sequelae. In all the other cases the procedure was well tolerated and no accidents occurred.

Several patients experienced slight headache and nausea. Tachycardia or bradycardia was noted in a few cases. Secondary meningeal reactions, as frequently occur after lumbar puncture, were occasionally observed.

SUMMARY

A method of carrying out encephalography based upon a material of 135 cases is described. Oxygen is injected into the cisterna magna above the occipital foramen and controlled roentgenographically during its upward passage. The hypertension thus induced is immediately relieved by allowing gas and/or cerebrospinal fluid to escape through the puncture needle. The method has been applied with good results in cases of cranial hypertension, even with expanding lesions of the posterior fossa.

ZUSAMMENFASSUNG

Eine Methode zur Ausführung der Encephalographie, die sich auf ein Material von 135 Fällen gründet, wird beschrieben. Sauerstoff wird in die Cisterna magna oberhalb des Foramen occipitale injiziert und dessen Ausbreitung nach oben röntgenographisch kontrolliert. Der auf diese Weise erzeugte Überdruck wird sofort dadurch ausgeglichen, dass man Luft und/oder Cerebrospinalflüssigkeit durch die Punktionsnadel ablaufen lässt. Die Methode ist mit gutem Resultat in Fällen mit intrakranieller Drucksteigerung und auch bei expansiven Prozessen der hinteren Schädelgrube benutzt worden.

RÉSUMÉ

Les auteurs décrivent, sur une série de 135 cas, une méthode d'encéphalographie. On injecte de l'oxygène dans la grande citerne au dessus du trou occipital et on contrôle radiographiquement son passage vers le haut. L'hypertension ainsi produite est immédiatement réduite en laissant échapper du gaz ou du liquide céphalo-rachidien par l'aiguille de ponction. Cette méthode a été appliquée avec de bons résultats dans des cas d'hypertension intracranienne, même en cas de tumeur de la fosse postérieure.

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MISE AU POINT DE L'IODOVENTRICULOGRAPHIE

par

Maria Luisa Morete de Pardal et *Enrique Pardal*

La ventriculographie au Lipiodol fut employée pour la première fois par SICARD et ses collaborateurs en 1923, qui l'abandonnèrent bientôt. En 1928, BALADO entreprit les premiers travaux de l'école argentine sur ce sujet, en étudiant de façon systématique les images du troisième ventricule, de l'aqueduc de Sylvius et du quatrième ventricule. LYSHOLM, en 1935, publia son expérience se rapportant à 114 cas. Il arriva à la conclusion que, bien que les images fussent claires, la substance de contraste était irritante pour l'épendyme et aggravait l'état du malade. Les critiques qui se sont élevées à l'égard du Lipiodol et l'épanouissement de la pneumoventriculographie ont fait que l'usage du Lipiodol par voie ventriculaire a été pratiquement écarté.

La recherche se dirigea alors vers d'autres substances de contraste positif. ANTONI en 1932 introduisit le Thorotrast qui fut essayé ensuite par SCHOENFELD et FREEMAN, ainsi que par TWINING et ROWBOTHAM. Les médecins anglais considérèrent le procédé comme recommandable quoique le dioxyde de thorium fût signalé comme un agent carcinogénétique, à cause de son dépôt dans le réticulendothélium. En 1934, ALEXANDER et, en 1938, REEVES et STUCK démontrèrent de fortes réactions histologiques provoquées par le Thorotrast.

CARRILLO, disciple de BALADO, attira de nouveau l'attention sur le Lipiodol en 1938 avec une publication portant sur 550 cas. Il établit la technique et donna les bases pour l'interprétation diagnostique des images,

en accord avec l'anatomie topographique et pathologique de la région. L'examen histologique de l'épendyme de cent cas autopsiés n'a révélé que dans quelques cas une infiltration sous-épendymaire et périvasculaire non spécifique. Aucun cas mortel n'a pu être attribué à la substance de contraste.

En 1942, le Pantopaque fut introduit dans la pratique de la myélographie par STEINHAUSEN et ses collaborateurs. En 1946, on l'utilise pour des ventriculographies. BULL l'employa dans 80 cas avec un résultat satisfaisant. Les communications sur les effets désagréables du Pantopaque n'ont pas manqué: des paralysies oculaires furent signalées par MACKAY, et des adhérences méningées par TARLOV, et même on a cité un cas mortel observé par ERICKSSON et VAN BAAREN.

A la Chaire de Neurochirurgie de Buenos Aires, de mars 1928 à mars 1957, nous avons mené à bien 1.280 ventriculographies au Lipiodol. Nous fondant sur ce matériel, le plus grand qui ait été publié, nous nous proposons de rapporter la technique suivie et ses accidents. L'interprétation des images obtenues ne rentre pas dans l'objet de ce rapport.

Indications. Le neurochirurgien possède aujourd'hui un ample bagage de techniques radiologiques pour l'examen du système nerveux central. La fosse postérieure peut être explorée à l'aide de la pneumoencéphalographie fractionnée et dirigée; mais lorsque les cavités se trouvent fortement comprimées et déplacées, les quantités d'air de remplissage sont petites et leurs images faibles; d'ailleurs, dans les cas de grandes hypertensions endocraniennes, la hernie amygdalienne peut se précipiter. Quant à l'angiographie par voie vertébrale, excellente dans le diagnostic des processus vasculaires, elle n'est point jusqu'à présent plus claire que le Lipiodol dans les cas de tumeur.

C'est dans l'étude du troisième ventricule, de l'aqueduc de Sylvius et du quatrième ventricule que ce procédé atteint son intérêt le plus grand. Le diagnostic des tumeurs de la fosse postérieure et la recherche de points de repères ventriculaires pour la chirurgie stéréotaxique trouvent un grand allié dans l'iodoventriculographie.

Nous indiquerons que notre expérience comprend quelques cas où le Lipiodol fut utilisé dans l'étude des tumeurs de la région sellaire et hémisphérique, mais cette conduite fut abandonnée en constatant la supériorité manifeste de l'angiographie carotidienne et des examens gazeux ventriculaires et cisternaux.

Tactique et technique. En accord avec la technique classique (BALADO, CARRILLO, et GHERZI, le patient est placé sur la table d'opération en décubitus ventral, la tête fortement ramenée sur la poitrine. Par trépanation occipitale, on introduit un ou deux millilitres Lipiodol dans la corne

occipitale du ventricule latéral, la substance de contraste glisse à cause de la position du malade vers la corne frontale. En retirant le trocart, il faut placer dans le ventricule une sonde de Nélaton que l'on ferme et fixe à la peau. On commence alors la phase radiologique de l'examen.

1. Le patient est transporté sur la table d'examen, toujours en décubitus ventral. Le front sur le plan horizontal de la table, on prend des films de profil et de face.

2. Le Lipiodol localisé, la deuxième démarche consiste à le faire passer par le foramen de Monro pour gagner le troisième ventricule, clef du procédé. Les malades atteints d'hydrocéphalie interne occasionnent quelques difficultés dans cette partie de l'étude, parce que le Lipiodol reste pris dans la profonde dépression du plancher de la corne frontale. Deux manoeuvres conduisent au but.

a) Celle qui fut employée par BALADO depuis 1928 et suivie par l'école argentine: on place la tête du malade en position latérale en faisant tourner le cou de sorte que le ventricule injecté reste en position supérieure. Le Lipiodol tombe alors dans le troisième ventricule et même une partie glisse vers le ventricule latéral du côté opposé, le passage en est facilité par un léger relèvement de la tête posée sur un oreiller.

On revient à la position initiale (le front sur le plan horizontal de la table) et l'on prend des films de face et de profil; ces images renseignent sur la partie antérieure du troisième ventricule.

b) La manoeuvre que nous préférons réaliser actuellement a été décrite par LYSHOLM en 1935, et mise au point parmi nous par AMEZUA en 1955, et a été en outre l'objet d'une publication réalisée par HORWITZ en 1956. Le patient, encore en décubitus ventral, le passage par le trou de Monro est provoqué par un simple relèvement de la tête en plaçant la table d'examen en position de Trendelenburg inversé. Une légère rotation de la tête peut être nécessaire vers le côté injecté. Le contrôle radiographique révèlera la position de l'huile iodée (Fig. 1).

3. Le remplissage du III ième ventricule ainsi accompli, le passage vers sa partie postérieure et vers l'aqueduc se réalise en faisant tourner le patient en décubitus dorsal, la table horizontalement placée. On prend un film de profil et un de face (Fig. 2).

4. Une élévation de la table en Trendelenburg inversé, à trente-cinq degrés, suffit pour que le Lipiodol glisse vers l'aqueduc et remplisse le quatrième ventricule, ou indique l'arrêt (Fig. 3).

Dans le cas de blocage, il se produit un retard dans la circulation, on peut alors prendre les films à intervalles et augmenter l'inclinaison de la table jusqu'à épuiser les possibilités de contraste.

Au cours de cette étude, nous diminuons, si c'est nécessaire, l'hypertension endocranienne par soustractions modérées de liquide cérébrospinal par la sonde ventriculaire. Si éventuellement le patient ne pouvait être opéré sur le champ, nous utilisons la même sonde pour effectuer une dérivation temporaire vers l'extérieur, grâce à laquelle on évite une aggravation possible du blocage attribuable à la viscosité du moyen de contraste.

Le Lipiodol peut être retiré pendant l'exploration. Il est fréquent que le système ventriculaire se débloquant, le Lipiodol apparaisse dans le champ opératoire; on en profite alors pour le retirer, au cas contraire on peut le faire plus tard par la voie lombaire.

Accidents. Comme nous l'avons dit plus haut, la viscosité du Lipiodol peut compliquer les blocages incomplets; c'est pourquoi nous insistons sur l'usage de la sonde de sécurité. En nous attachant à la tactique et à la technique décrites, les accidents se sont réduits à des hyperthermies, des rachialgies et des radiculalgies sans gravité.

RÉSUMÉ

L'intérêt de la ventriculographie au Lipiodol a été amplement prouvé par son application à 1.280 cas. Elle est d'exécution facile et pratiquement inoffensive. L'usage de quantités modérées de contraste et la sonde de sécurité réduisent les complications au minimum. La netteté des images conduit à des diagnostics précis. La meilleure indication est l'étude du troisième ventricule, de l'aqueduc de Sylvius et du quatrième ventricule.

SUMMARY

The value of ventriculography with Lipiodal was demonstrated in a material of 1,280 cases. The method is an easy one to perform and practically devoid of danger, the employment of moderate amounts of contrast medium and a 'safety' catheter reducing the complications to a minimum. The sharpness of the images produced assists in an accurate diagnosis. Examinations of the third ventricle, aqueduct, and fourth ventricle are particularly suitable ones in which to sue this procedure.

ZUSAMMENFASSUNG

Der Wert der Ventrikulographie mit Lipiodol ist eindrücklich durch ihre Anwendung in 1.280 Fällen gezeigt worden. Ihre Ausführung ist leicht und praktisch ohne Risiko. Die Anwendung mässiger Mengen des Kontrastmittels und die Sicherheitsprobe reduzieren die Komplikationen auf ein Minimum. Die Bildschärfe führt zu einer genauen Diagnose. Die besten Indikationen sind Untersuchungen des 3. Ventrikels, des Aquäduktes und des 4. Ventrikels.

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AUS DER RÖNTGENABTEILUNG (LEITER: PRIVATDOZENT K. DECKER) DER UNIVERSITÄTS-NERVENKLINIK (DIREKTOR: PROF. K. KOLLE), MÜNCHEN, DEUTSCHLAND

ENCEPHALOGRAPHIE AM BILDWANDLER

VON

O. Wiedenmann und *K. H. Leuchs*

Die encephalographische Untersuchungstechnik hat in den letzten Jahrzehnten wesentliche Verbesserungen erfahren. Bei der Anfertigung einiger Röntgenaufnahmen nach Abschluss der Lufteinblasung war es weitgehend dem Zufall überlassen, welche Abschnitte der Liquorräume zur Darstellung kamen.

DAVIDOFF und DYKE unternahmen die ersten Versuche, die Liquorräume der hinteren Schädelgrube durch eine Aufnahme im Sitzen während der Lufteinblasung gezielt darzustellen. Aber erst die von LINDGREN entwickelte Methode der Encephalographie im Sitzen mit fraktionierter Einblasung der Luft erlaubte eine zuverlässige Darstellung praktisch aller für die klinische Diagnostik wesentlichen Abschnitte des Ventrikelsystems und der Subarachnoidalräume. Die Anpassung der Kopfhaltung an die anatomischen Gegebenheiten des Schädelinhaltes und an die physikalischen Bedingungen der Bewegung des Kontrastgases sind wesentliche Hilfsmittel seiner Untersuchungstechnik. Auch der Zeitpunkt der Exposition mancher Aufnahme wurde dem Durchgang des Kontrastmittels angepasst. Es lag nun nahe, eine Untersuchungsmethode wie die Encephalographie, bei der der Luft-Liquoraustausch einen bewegten Vorgang darstellt, auch im Durchleuchtungsbild beobachten zu wollen. Die gewöhnliche Durchleuchtung war ungeeignet, da auf dem Bildschirm Gaskontrast kaum zu erkennen war und die Asepsis im dunklen Raum gefährdet ist. Auch die Überwachung des Patienten ist erschwert. Erst die Einführung des Bildwandlers machte es möglich, Einzelheiten im Schädel während der Encephalographie gut zu erkennen.

Untersuchungsgerät

Der von uns benützte Bildwandler (Fa. C. H. F. Müller) hat ein Krei-format von 13 cm Durchmesser. Etwa die Hälfte des grössten Schädeldurchmessers ist im Blickfeld. Die leichte, vollautomatische Beweglichkeit des Patienten in mehreren Richtungen in dem Untersuchungsgerät UG X erlaubt es, in wenigen Sekunden den gesamten Schädel und den Cervicalbereich zu überblicken. Es ist das Blickfeld auch gross genug, um z. B. die ganze hintere Schädelgrube einschliesslich des atlanto-occipitalen Überganges, der retrosellären Region und der hinteren Abschnitte des 3. Ventrikels ohne Bewegung des Patienten zu erfassen. Die Einstellung sagittaler Aufnahmen ist etwas schwieriger, da sie von der Seite her erfolgen muss — vor dem Patienten ist der Bildwandler, hinter ihm die Lagerungswanne. Die Kontrolle der achsengerechten Einstellung kann nur mit der Durchleuchtung erfolgen. Die Lumbalpunktion erfolgt durch einen Ausschnitt in der Lagerungswanne, was anfänglich Schwierigkeiten machen kann. Der Patient sitzt in einer Lagerungswanne, die zur Lumbalpunktion und für die seitlichen Aufnahmen etwa 20 bis 30 Grad nach rückwärts geneigt ist. Der Rumpf wird durch Gurte gehalten, der Kopf wird auf strahlendurchlässige Polster in der gewünschten Haltung gelagert, wie aus der Abbildung hervorgeht. Für den Untersuchten wird so eine ziemlich bequeme Lagerung erreicht; sollte er kollabieren, ist er in wenigen Sekunden automatisch in die Horizontallage zu bringen.

Wir haben den Bildwandler mit einer Kinokamera kombiniert, um unsere Durchleuchtungsbeobachtungen reproduzierbar zu machen. Es handelt sich um eine Spiegelreflex-Kamera der Firma Arnold und Richter (Typ II A Rö.) mit einem Filmformat von 35 mm. Dieses Format scheint uns für die Reproduktion günstiger als das Schmalfilmformat. Wir haben den Eindruck, dass die Bildschärfe durch das Umkopieren auf den 16 mm Film gewinnt. Nur Filmstreifen, die zur Vorführung bei wissenschaftlichen Tagungen und Kongressen bestimmt sind, werden in das Kleinformat übertragen. Für die Auswertung in unserem Institut verwenden wir eine 35 mm Arbeitskopie, die 1 bis 2 Tage nach der Aufnahme verfügbar ist und an einem in der Filmbranche üblichen Schneidetisch (Cinetti von Arnold und Richter) vorgeführt wird. Als Negativ-Material verwenden wir Gevapan 36, Type 191 (Firma Gevaert).

Die Filmaufnahmen werden mit 110 kV und 8 mA exponiert, 24 Aufnahmen pro Sekunde werden belichtet. Bei Untersuchungen am Bildwandler ohne Filmaufnahmen kommt man gut mit einer Stromstärke von 3 bis 4 mA aus. Der r-Minutenzufluss im Strahlenbündel, gemessen an der röhrenseitigen Hautoberfläche des Patienten, beträgt bei Kinoaufnahmen maximal 36 r pro Minute, bei Durchleuchtung 9 r pro Minute. Eine Untersuchung ergibt im Durchschnitt eine Beobachtungszeit von

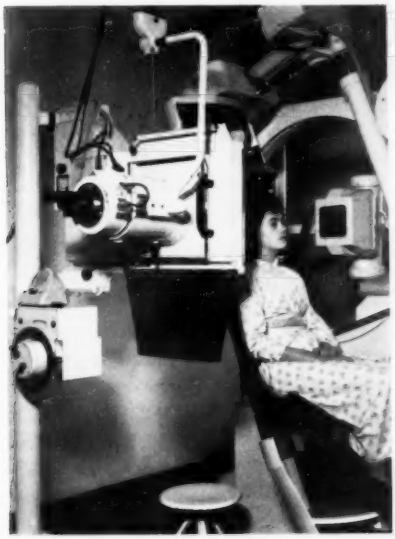

Abbildung des Untersuchungsgerätes mit Bildwandler und Filmkamera.

etwa 1 Minute, nie mehr als zwei Minuten. Für Ärzte und Personal, deren Strahlenbelastung ständig geprüft wird, war selbst bei reger Filmtätigkeit mit zwei bis drei Aufnahmen pro Tag die Belastung nie mehr als 0.1 r pro Woche. Filmaufnahmen werden jetzt nur noch bei jenen Patienten angefertigt, bei denen Besonderheiten des Füllungsvorganges zu erwarten sind oder eine spezielle Fragestellung vorliegt. Die Filmaufnahme unterbricht den Beobachtungsgang durch die Spiegelreflexoptik nicht. Von allen wesentlichen Situationen werden ausserdem Einzelaufnahmen in Grossformat angefertigt.

Untersuchungstechnik

Der Untersuchungsgang beginnt mit der Lumbalpunktion, die richtige Nadellage wird durch das Ablassen von wenigen Tropfen Liquor geprüft. Der Kopf wird zur Füllung der inneren Liquorräume mit angezogenem Kinn in leichter Ventralbeugung gelagert, im Bildwandler wird der atlanto-occipitale Übergang eingestellt.

Zeigt sich nach dem Einblasen der ersten Kubikzentimeter Kontrastgases ein Stop im oberen Cervicalabschnitt mit in den Spinalkanal eintretenden Kleinhirntonsillen, kann die Untersuchung sofort abgebrochen

werden. (Wir haben eine Reihe von Kontrastgasen auf ihre Brauchbarkeit bei der Encephalographie geprüft (H_2, He, O_2, Ne, Kr, NO_2). Wasserstoff und Helium, aber auch Krypton haben sich gut bewährt. Bei ausreichendem Kontrast sind die postencephalographischen Beschwerden wesentlich geringer als mit Luft.) Liegt eine andersartige Behinderung des Kontrastgases vor, wird eine Füllung der Liquorräume durch Änderung der Kopfhaltung und des Neigungswinkels des ganzen Patienten unter unmittelbarer optischer Kontrolle versucht. Kommen die intracraniellen Liquorräume zur Darstellung, so wird nach den Grundsätzen der LINDGREN'schen Technik weiter untersucht. Einzelaufnahmen, deren Format vom Bildwandler unabhängig ist, werden trotz der laufenden Durchleuchtungsbeobachtung und eventueller Kinofilmaufnahmen von allen wesentlichen Situationen hergestellt.

Da die Entwicklung dieser Aufnahme nicht abgewartet werden muss, verkürzt sich die Untersuchungszeit.

Abgeschlossen wird die Encephalographie mit den Übersichtsaufnahmen am Lysholm-Tisch in Standard-Technik und gegebenenfalls mit speziellen Projektionen.

Beobachtungen

Eine schriftliche Mitteilung kann so wenig wie einige Bilder die Beobachtung von Bewegungsvorgängen ersetzen. Die Umstände zwingen uns jedoch, mit Worten einen ungefähren Eindruck von dem zu vermitteln, was wir mit unseren eigenen Augen am Bildwandler sehen, und, zum Teil in Filmaufnahmen erfasst, beim Symposium in Brüssel zeigen konnten.

Die erste Aufmerksamkeit bei Beginn der Gasinjektion gilt dem atlanto-occipitalen Übergang. Beim normalen Füllungsvorgang ist — in gewisser Abhängigkeit von der Geschwindigkeit der Gasinjektion und der Haltung des Kopfes — keine oder nur eine flüchtige Gasansammlung in der Cisterna magna und im oberen cervicalen Spinalkanal zu beobachten. Das Gas tritt dabei genau in der Mittellinie, also durch das Foramen Magendi in den 4. Ventrikel ein. Wird das Gas rasch injiziert oder besteht eine leichte Fehlhaltung des Kopfes mit zu starker Dorsalflexion, werden die Cisterna pontis und die supraselläre Cisterne mitgefüllt. Ist der Kopf etwas zu stark nach ventral geneigt, manchmal aber auch ohne erkennbaren Grund, füllt sich zunächst der Subarachnoidalraum um den caudalen Kleinhirnpol und ein Teil der Cisterna magna, ehe im 4. Ventrikel Gaskontrast erscheint und die Füllung der inneren Liquorräume beginnt. Wir möchten letzteren Füllungsvorgang als einen zweiten Normaltyp ansehen. Ist die Passage des Kontrastgases nach cranial in der Gegend des Foramen magnum behindert, kommt es zu einer Ansammlung im cervicalen Spinalkanal. Die Ursachen hierfür sind verschieden, auch das

Durchleuchtungsbild zeigt unterschiedliche Befunde. Als Folge einer intracraniellen Raumbeschränkung haben wir einigemal Verlagerungen der Kleinhirntonsillen in den Spinalkanal beobachten können. Es war überraschend zu sehen, dass diese nach bisheriger Vorstellung mechanisch im Foramen magnum fixierten Kleinhirnteile allseitig frei sind und pulssynchron im Liquorraum nach caudal und cranial schwingen, wobei meist eine schmale Luftsichel am Hinterrand der Cisterna magna nach intracraniell reicht. Gleichzeitig pulsiert der tiefer stehende Luft-Liquorspiegel im cervicalen Spinalkanal. In einigen dieser Fälle trat im Verlauf der Untersuchung noch etwas Luft in die Subarachnoidalräume, vorwiegend die parasellären Cisternen. Eine Füllung der inneren Liquorräume konnten wir bei einem derartigen Befund noch nicht beobachten.

Eine andere Art von Stopbildung am Foramen magnum war bei atlanto-occipitalen Übergangsanomalien zu beobachten. Hier war keine stärkere Tonsillenverquellung zu erkennen, es pflegten sich die Subarachnoidalräume, die supratentoriellen und gelegentlich die infratentoriellen zu füllen. Der Eintritt des Kontrastmittels durch das Foramen magnum war nur erheblich verzögert, eine Füllung der inneren Liquorräume konnte nicht immer erzielt werden.

Differentialdiagnostisch ist von Bedeutung, dass immer dann, wenn die Behinderung des Kontrastgases am Durchtritt durch das Foramen magnum durch raumfordernde intracranielle Prozesse oder durch anatomische Anomalien bedingt war, der cervicale Luft-Liquorspiegel pulsierte. Eine nicht pulsierende Luftsäule im cervicalen Spinalkanal konnten wir bisher lediglich bei subduraler Lage der injizierten Luft beobachten.

Dringt das Kontrastgas in den 4. Ventrikel ein, füllt sich zunächst dessen craniale, in den Aquaeduct mündende Spitze. Ob und inwieweit es zu einer Auszeichnung der caudalen Abschnitte des 4. Ventrikels kommt, hängt davon ab, ob eine genügende Menge Luft ausreichend schnell injiziert wird, da normalerweise ständig Luft durch den Aquaeduct abfliesst. Bei vergrössertem 4. Ventrikel und bei einem breiten Aquaeduct kann die erforderliche Injektionsgeschwindigkeit und die notwendige Luftmenge überraschend gross sein. Wir haben im Film ein Beispiel einer Erweiterung eines Ventrikelsystems gezeigt, bei dem der 4. Ventrikel nur dadurch annähernd gefüllt werden konnte, dass 15 ml Luft mit grösstmöglicher Geschwindigkeit eingeblasen wurden. Ein unvollständig gefüllter 4. Ventrikel kann Konturen zeigen, die einer vollständigen Füllung täuschend ähnlich sind. Bei der Durchleuchtung erkennt man jedoch den bewegten Flüssigkeitsspiegel in den caudalen Abschnitten des 4. Ventrikels. Der Übertritt der Luft vom 4. Ventrikel in den Aquaeduct kann kontinuierlich erfolgen oder mit einzelnen Luftblasen, die pulssynchron ausgestossen werden, mitunter von entsprechenden pulsatorischen Bewegungen des langsam ansteigenden Luft-Liquorspiegels im

4. Ventrikel begleitet. Ähnlich verhält es sich beim Übertritt der Luft vom Aquaeduct in den 3. Ventrikel, besonders wenn die Einmündung des Aquaeducts sehr eng ist.

Der 3. Ventrikel füllt sich bei der üblichen Kopfhaltung mit angezogenem Kinn und leichter Ventralneigung zunächst in seinen dorsalen und oberen Abschnitten, der Recessus suprapinealis ist meist der erste sich darstellende Teil. Das Foramen Monroi liegt tiefer als die dorsalen Abschnitte des 3. Ventrikels, und erst wenn der Liquorspiegel bis zu dieser Höhe abgesunken ist, tritt Luft in die Seitenventrikel ein. Ein leichtes Rückwärtsneigen des Kopfes führt zu beschleunigtem Luftübertritt aus dem 3. in die Seitenventrikel. Gelegentlich beobachtet man eine pulsierende Schaukelbewegung des Luft-Liquorspiegels im 3. Ventrikel in ventrodorsaler Richtung und umgekehrt. In jener Phase, in der der Liquorspiegel in den ventralen Abschnitten des 3. Ventrikels nach unten, gegen den Recessus opticus pendelt, treten gleichzeitig eine oder mehrere Luftblasen durch das Foramen Monroi in die Seitenventrikel.

Der Durchtritt der Luft in das Foramen Monroi ist sowohl im seitlichen wie im sagittalen Strahlengang eindrucksvoll zu beobachten. Ein Vergleich mit den Kohlensäureblasen im Mineralwasser oder im Sekt drängt sich hier auf.

Bewegt sich der Patient oder hustet er, so sind wellenförmige Bewegungen des Liquors in den Seitenventrikeln zu erkennen. Wird der Patient mit luftgefüllten Seitenventrikeln in die Horizontale oder in leichte Kopftieflage gebracht, so sind auch rückläufige Luftbewegungen aus den Seitenventrikeln in den dritten zu erkennen.

Die Füllung der Basalcisternen erfolgt mit leicht nach rückwärts geneigtem Kopf, wir stellen den Clivus unter Durchleuchtungskontrolle annähernd senkrecht. Die Luft dringt zunächst über den Clivus in die Cisterna pontis und von da weiter in die supraselläre Cisternen. Gleichzeitig füllt sich in dieser Stellung fast immer die Cisterna ambiens, der Luftstrom teilt sich also in eine rostrale und eine mehr dorsal gerichtete Bahn. Häufig erkennt man in der Cisterna pontis die deutliche Pulsation der A. basialis, nicht selten auch die Bewegung der A. carotis in ihrem Syphonabschnitt. Auffällig ist die inkonstante Darstellung der Konturen der supraselläre Cisternen. Die Luft wandert sehr schnell einerseits nach vorne zu den Cisternen der vorderen Schädelgrube, in den Interhemisphärenspalt und über die Konvexität des Stirnhirns, andererseits zur Cisterna ambiens und über die Lamina quadrigemina. Ob eine Füllung der Zisternen um die Vierhügelplatte und Cirbel auch auf andere Weise zustande kommen kann, etwa über die Subarachnoidalräume des Kleinhirns, konnten wir noch nicht sicher feststellen. Das ständig wechselnde Füllungsbild der supraselläre Cisternen sowie der basalen Abschnitte der vorderen Schädelgrube lässt die Durchleuchtungsbeobachtung als

einen besonderen Vorteil erscheinen. Sie erlaubt es, durch leichte Änderungen der Kopfhaltung und Anpassung der Injektionsgeschwindigkeit und der eingebrachten Luftmenge, die interessierenden Abschnitte dieser Region genauer zu beobachten und durch gezielte Einzelaufnahmen oder Kinofilm festzuhalten.

Die Füllung der Kleinhirnbrückenwinkelcisternen kann nicht unmittelbar beobachtet werden, da bei rückwärtsgeneigtem Kopf dieses Gebiet im sagittalen Strahlengang durch knöcherne Strukturen zu stark überlagert ist. Hingegen ist die Kontrolle, ob der Füllungsversuch erfolgreich war, nach Vorwärtsneigen des Kopfes im Durchleuchtungsbild einfach. Es bleibt noch darauf hinzuweisen, dass ohne Schwierigkeiten die encephalographische Untersuchung durch eine Darstellung des cervicalen Spinalkanals ergänzt werden kann. Der Patient wird mit der Lagerungswanne in die Horizontallage gebracht und der Kopf nach hinten gebeugt. Manchmal ist es zweckmässig, ein Polster unter die Schultern zu legen. Bei Beginn der Lufteinblasung stellt sich zunächst der ventrale Subarachnoidalraum im Scheitel der Halslordose dar, bei weiterem Füllen der gesamte ventrale, dann auch der dorsale Subarachnoidalraum. Durch leichte Änderungen des Neigungswinkels der Lagerungswanne kann ein vorzeitiger Übertritt des Kontrastgases durch das Foramen magnum in das Schädelinnere vermieden werden. Richtet man dann den Patienten langsam wieder in die Senkrechte auf, kommen die ventralen Konturen des Spinalkanals am atlanto-occipitalen Übergang und der Subarachnoidalraum über dem Clivus gut zur Darstellung. Mit der Ergänzung der Encephalographie durch diese Art der cervicalen Myelographie wird eine diagnostische Einheit erreicht, die bei manchen klinischen Fragestellungen wünschenswert ist.

Besprechung

Der Luft-Liquoraustausch, ein bewegter Vorgang, kann jetzt durch den Bildwandler in seinen Einzelheiten beobachtet werden. Der Füllungsvorgang ist unter unmittelbarer Kontrolle des Auges steuerbar. Die Röntgenuntersuchung der cerebralen und spinalen Liquorräume hat hierdurch eine Vervollständigung erfahren, wie wir sie etwa von der Kontrastuntersuchung des Magens und anderer Hohlorgane längst gewohnt sind. Pulsatorische Eigenbewegungen des Gehirns und der grossen Arterien in den Basalcisternen sowie entsprechende Mitbewegungen des Luft-Liquorspiegels konnten erstmals am geschlossenen Schädel in einer Röntgenuntersuchung sichtbar gemacht werden. Man hat den Eindruck, dass diese Pulsationen aktiv am Transport des Kontrastgases mitwirken, dieses sich also nicht nur nach den physikalischen Gesetzen der Bewegung von Gasen in Flüssigkeit in den Liquorräumen sammelt. Die bisherige Auffassung, dass die „Tonsillen-Einklemmung" eine mecha-

nische, starre Einklemmung dieser Kleinhirnteile im Foramen magnum sein müsse, konnte widerlegt werden. Die Kleinhirntonsillen können tief in den cervicalen Spinalkanal eintreten, hängen hier aber frei und zeigen pulsierende Bewegung. Durch die Anfertigung von Kinoaufnahmen ist das Durchleuchtungsbild reproduzierbar geworden. Die diagnostische Auswertung flüchtiger Abläufe wird hierdurch erleichtert. Der einzelne Untersuchungsgang bleibt als Filmstreifen für die wissenschaftliche Bearbeitung und für Lehrzwecke jederzeit zugänglich.

Einige Nachteile müssen noch in Kauf genommen werden. So besteht die Notwendigkeit, neben dem Lysholm-Tisch, an dem die Übersichtsaufnahmen angefertigt werden, für die Untersuchung am Bildwandler ein eigenes Gerät zu benützen. Der Vergrösserungsfaktor der am UG X angefertigten Aufnahmen ist etwas grösser als am Lysholm-Gerät, was bei der Betrachtung der Bilder berücksichtigt werden muss. Gewisse Schwierigkeiten bei der Einstellung der Aufnahmen im sagittalen Strahlengang und bei der Lumbalpunktion wurden bereits erwähnt. Die Vorteile dieser Untersuchungsmethode überwiegen aber zweifellos.

Die Technik der Encephalographie am Bildwandler wurde unter Anregung und Leitung von K. Decker an unserer Klinik entwickelt. Der erste Filmstreifen wurde beim Kongress der Bayerischen Röntgengesellschaft im Oktober 1956 in Garmisch gezeigt und weitere Filme im November und Dezember 1956 in Nordamerika und Kanada. Am 24. 3. 57 demonstrierte Decker einen ähnlichen Film in Modena beim Kongress der italienischen Röntgenologen der Gruppe Emiliano Marchigiano.

Die beim Symposium Neuroradiologicum gebotene Fassung des Encephalographiefilmes wurde von K. Leuchs und O. Wiedenmann bearbeitet.

Herrn K. Decker sind wir für viele Anregungen und die Überlassung des Themas zu grossem Dank verpflichtet.

ZUSAMMENFASSUNG

Eine neuartige Technik der Encephalographie wird beschrieben. Sie besteht in der Durchleuchtungsbeobachtung des Füllungsvorganges mit Hilfe eines Bildwandlers an einem speziellen Untersuchungsgerät. Die Durchleuchtungsbeobachtungen bei den encephalographischen Untersuchungen im Normalfall und unter einigen pathologischen Bedingungen werden beschrieben.

SUMMARY

A new technique of encephalography is presented in which fluoroscopy of the filling procedure is performed with the help of an image intensifier fitted to a special examination apparatus. The fluoroscopic appearances observed in the encephalographic examination of normal and pathologic conditions are described.

RÉSUMÉ

Les auteurs présentent une nouvelle technique d'encéphalographie dans laquelle on examine radioscopiquement le remplissage, grâce à un amplificateur de brillance adapté à un appareil spécial. Ils décrivent les images radioscopiques observées au cours de l'encéphalographie de cas normaux et pathologiques.

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VENTRICULOGRAPHIE FRACTIONNÉE TÊTE BASSE

Méthode de diagnostic des tumeurs de la fosse postérieure et du tronc cérébral

par

E. Laine, G. Riff, J. M. Delandtsheer et *P. Galibert*

La ventriculographie, que nous devons à DANDY, a vu, ces dernières années, se restreindre peu à peu ses indications. En ce qui concerne les tumeurs sus-tentorielles, elle a été détrônée par l'angiographie carotidienne et l'encéphalographie gazeuse fractionnée. Lorsque le siège de la néoformation est sous-tentorielle, elle est assez souvent aussi supplantée par l'angiographie vertébrale ou l'encéphalographie fractionnée. Chaque fois que la tumeur s'est développée dans l'angle pontocérébelleux, qu'elle est située en dehors du cervelet ou du tronc cérébral, qu'il s'agisse d'un méningiome ou d'un neurinome, ces méthodes complétant les données des radiographies sans préparation font à coup sûr le diagnostic.

Par contre, lorsque la tumeur a pris naissance dans le cervelet ou sur les parois du quatrième ventricule et réalise l'obstruction complète de ce dernier, elle ne permet pas le passage de l'air vers sa partie supérieure, l'aqueduc ou le troisième ventricule; les données de l'encéphalographie gazeuse par voie lombaire restent forcément très incomplètes. D'autre part, l'angiographie vertébrale ne nous permet guère de dire si une tumeur née dans le cervelet infiltre ou non la protubérance ou le bulbe.

C'est dans ce cas très précis que la ventriculographie garde ses indications.

Cependant, même alors la technique classique présente des inconvénients graves.

L'injection d'une quantité relativement importante d'air dans les ventricules latéraux et le troisième dilatés est souvent mal tolérée, même si on prend la précaution de remplacer immédiatement le gaz par du sérum physiologique et d'opérer séance tenante pour enlever la tumeur ou rétablir, dans un temps préalable, la circulation du liquide ventriculaire par incision de la lame sus-optique.

En outre, le remplissage inévitable du carrefour et des cornes temporales masque en partie l'aqueduc de Sylvius, et souvent aussi la partie la plus intéressante du troisième ventricule, c'est-à-dire le plancher et le fond de cette cavité. Que des cellules mastoïdiennes volumineuses se surajoutent encore à ces images, l'interprétation des clichés devient délicate, parfois sujette à erreur. Aussi, s'est-on efforcé d'améliorer les images de ces cavités.

La prise des clichés dans certaines positions, bien décrites par différents auteurs, LYSHOLM, LINDGREN, TWINING, en particulier, améliore le remplissage, mais ne supprime pas la superposition des cornes temporales. Il était donc intéressant de chercher à éliminer ces images parasites. VERBIEST y parvient en remplissant, après une ventriculographie totale, les ventricules latéraux avec du liquide de HARTMAN, tout en laissant persister l'air contenu dans le troisième, l'aqueduc et le quatrième ventricule. MALMROS a décrit une technique analogue. Plus séduisante est la technique employée depuis des années par ZIEDSES DES PLANTES. En effet, elle ne nécessite que l'injection d'une quantité très limitée d'air. Cette bulle gazeuse, par basculements successifs, est amenée à remplir électivement les cavités ventriculaires centrales. Très facile pour les nourrissons, elle est d'une réalisation plus délicate chez l'adulte.

Nous avons, pour notre part, cherché depuis quelques années à réaliser une ventriculographie sélective du troisième ventricule et de l'aqueduc en faisant parvenir d'emblée le gaz de contraste (air ou oxygène) dans ces cavités à travers le trou de Monro. La technique que nous avons, après quelques tâtonnements, mise au point est exposée ci-dessous.

Une trépano-ponction de la corne frontale à l'aplomb du trou de Monro est tout d'abord réalisée. Nous la faisons au niveau de la suture coronale sur le plan sagittal passant par le milieu de l'orbite. Sur la table d'opération la dure-mère est incisée, ce qui permettra ultérieurement le passage d'un trocart mousse. La plaie est suturée.

Le malade est ensuite transporté sur la table basculante de radiodiagnostic et fixé solidement sur cette dernière à l'aide d'une sangle. Le trocart est mis en place. Il est dirigé légèrement en dedans dans un plan frontal. Son extrémité se trouve ainsi en regard du trou de Monro ou légèrement en avant de lui. A ce moment, on bascule la table pour amener

le patient, tête en bas, à la verticale. Nous inclinons la tête du malade de 15 degrés environ vers l'épaule opposée au trou du trépan. En même temps, nous la tournons légèrement autour de son axe vertical vers le côté où l'air va être injecté; ceci permet d'amener le trou de Monro de ce côté, un peu en arrière de l'autre, et l'air ne risque pas de franchir ce dernier pour se perdre dans le carrefour ventriculaire correspondant. Il file directement en direction de l'aqueduc et le remplit, ainsi que le fond du troisième ventricule. Il ne faut pas injecter plus de 8 ml, ou 10 au maximum, de gaz pour obtenir un cliché correct. Cet air est injecté par barbotage, de façon à retirer exactement la même quantité de liquide, à ne pas réduire la distension ventriculaire, à ne pas provoquer non plus un engagement sus-tentoriel du cervelet que la position tête basse pourrait favoriser.

Une fois l'air injecté, la tête est ramenée de face dans une position intermédiaire entre flexion et déflexion. Un premier cliché de profil centré sur le troisième ventricule est pris aussitôt. Il est suivi de deux clichés pris successivement en position de déflexion de plus en plus accusée de manière à obtenir une accumulation de plus en plus importante de l'air dans la partie postérieure du troisième ventricule et éventuellement l'aqueduc et le quatrième.

Pendant la prise de ces clichés de profil, il est utile d'effacer les cartilages du pavillon de chaque oreille, en les maintenant éversés vers l'avant par un ruban de leucoplast. Enfin, un dernier cliché de face en incidence sus-occipito-bregmatique est effectué, de manière à mettre en évidence un éventuel déplacement transversal du quatrième ventricule, sinon de l'aqueduc.

Dès que l'exploration radiologique est terminée, la table est ramenée en position horizontale. Un trocart ventriculaire est de nouveau enfoncé dans la corne frontale tandis que la tête, tournée vers le côté opposé, est soulevée de telle manière que la corne frontale occupe la position la plus élevée par rapport aux autres éléments du système ventriculaire.

C'est dans ces conditions, à l'intérieur de cette corne, que s'accumule le gaz qu'il est facile d'évacuer en totalité. La série de clichés que nous présentions à ce V^{e} Symposium Neuroradiologicum et qui ont été reproduits dans un de nos précédents travaux (J. Radiol. Electrol. 38 (1957), 86.) montre de quelle précision sont les renseignements que l'on peut obtenir sur les modifications des ventricules médians et de l'aqueduc que provoquent le refoulement ou l'infiltration par une tumeur des parois ventriculaires.

Lorsque la tumeur y a pris naissance, les infiltre secondairement ou efface complètement la lumière des ventricules, cette ventriculographie fractionnée tête basse nous semble pouvoir être proposée comme une méthode de choix.

RÉSUMÉ

Dans la pratique des auteurs, la ventriculographie n'est plus guère utilisée que dans les cas de tumeurs de la fosse postérieure ou du tronc cérébral qui bloquent l'aqueduc de Sylvius ou le quatrième ventricule. Une technique de ventriculographie fractionnée qui leur permet de ne remplir d'air que le troisième ventricule et la partie haute de l'aqueduc est décrite. Le dessin du plancher du troisième ventricule et de la partie supérieure de l'aqueduc n'est plus masqué par celle du carrefour et des cornes temporales, les déformations imprimées par la tumeur sont évidentes.

SUMMARY

The authors employ ventriculography only in cases of tumours situated in the posterior frossa or brain stem and causing occlusion of the fourth ventricle or the cerebral aqueduct. A technique of 'fractionated ventriculography' is described. By this method only the third ventricle and the superior portion of the aqueduct are filled and these are not obscured by the temporal horns of the lateral ventricles. Any deformations produced by tumours are well shown.

ZUSAMMENFASSUNG

Die Verfasser haben die Ventrikulographie nur in den Fällen mit Tumoren der hinteren Schädelgrube oder des Hirnstammes benutzt, welche für eine mehr oder weniger starke Blockierung der 4. Ventrikels oder des Aquaeductus mesencephali verantwortlich waren. Eine »fraktionierte« Ventrikulographietechnik wird beschrieben, die es erlaubt, nur den 3. Ventrikel und den oberen Teil des Aquaeductus mit Luft zu füllen. Der untere und hintere Abschnitt des 3. Ventrikels und der obere Teil des Aquaeductus mesencephali werden nicht länger durch die Temporalhörner verdeckt. Tumorbedingte Verlagerungen werden deutlich sichtbar.

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FROM THE MONTREAL NEUROLOGICAL INSTITUTE, MONTREAL, CANADA

RADIOLOGICAL ASPECTS OF CEREBELLAR ASTROCYTOMAS AND MEDULLOBLASTOMAS

by

D. L. McRae and *Arthur W. Elliott*

It has been shown that patients with medulloblastomas of the cerebellum tend to live longer if treated by a combination of biopsy and radiation therapy than if treated by excision alone (4). The question of treating medulloblastomas by radiation therapy alone therefore arose. Before this could be considered it was necessary to determine whether medulloblastomas of the cerebellum could be diagnosed on radiological grounds alone. Therefore, case records and roentgen films of all patients having posterior fossa operations at the Montreal Neurological Institute were reviewed. They were divided into three groups: 1) from the opening of the institute in 1934 to the end of 1945, 2) from January 1st, 1946 to December 31st, 1955, during which time vigorous efforts were being made to fill the 4th ventricle with gas, and 3) from January 1956 to May 1957, during which time the diagnosis of medulloblastoma was attempted before either biopsy or excision.

Gross analysis of all cases of different lesions and of different types of tumors revealed so much overlapping that nothing of value came from this. However, by selecting only patients from birth to 15 years of age (Diagrams 1 and 2) it was possible to establish some fairly reliable criteria. Unfortunately they were not sufficiently reliable to enable us to differentiate all cerebellar tumors in infants and children during the test period. During the 17 month test period there were 4

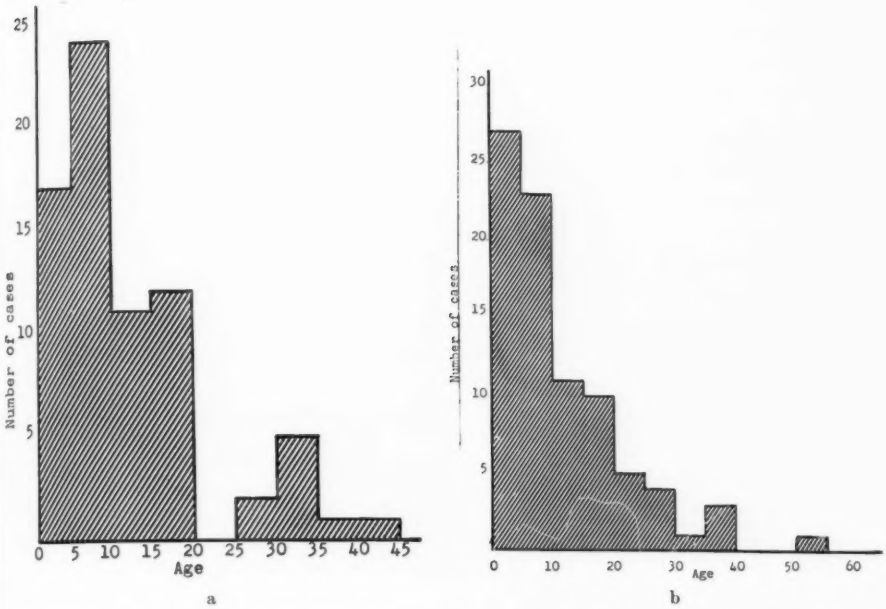

Diagram 1. Age distribution in 75 cases of astrocytoma (a) and in 86 cases of medulloblastoma (b).

medulloblastomata, 3 correctly diagnosed before biopsy and 1 incorrectly diagnosed as astrocytoma. There were 3 cerebellar astrocytomata, age 15 or below, all correctly diagnosed before biopsy or operation. There were no ependymomata or hemangioblastomata in patients of this age group during that time. There was 1 dermoid, recognized as such because of a tunnel in the bone at the internal occipital protuberance. There was 1 cerebellar tumor in a 7-month old child which we thought would be an astrocytoma but the pathologist labelled it 'glioma, unclassified'. Some interesting points relative to both technical and diagnostic factors became apparent and will be described herewith.

We follow LYSHOLM's (2) topographical classification of lesions affecting the 4th ventricle:

1. Pontine and pre-pontine tumors
2. Cerebello-pontine angle tumors
3. Tumors of the roof of the 4th ventricle above fastigium
4. Tumors of the cerebellar hemispheres
5. Tumors of the floor and roof of the fourth ventricle below fastigium
6. Intraventricular tumors of the 4th ventricle
7. Posterior fossa arachnoiditis

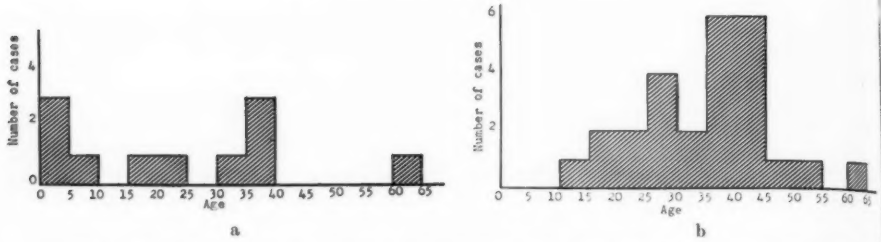

Diagram 2. Age distribution in 11 cases of ependymoma (a) and in 28 cases of hemangioblastoma (b).

In groups 1 and 2 the 4th ventricle is nearly always easy to demonstrate by gas encephalography and the encephalographic picture is characteristic. In group 7 the 4th ventricle is easy to fill by gas ventriculography and presents a characteristic picture. Therefore this paper is confined to the tumors found in groups 3, 4, 5, and 6, that is, tumors of the cerebellar hemispheres and of the vermis with a few tumors of the dorsal surface of the medulla oblongata which cannot be differentiated from inferior vermis tumors by ventriculography or encephalography.

Common cerebellar tumors 1934 to 1955, all ages

Type of tumor	Total cases	Cases with skull films	Cases with air studies
Astrocytoma	75	71	65
Medulloblastoma	86	79	73
Hemangioblastoma	28	27	25
Ependymoma	11	9	9
	200	186	172

Ventriculography versus encephalography in cerebellar tumors. In 15 of these patients a lumbar encephalogram was carried out following the ordinary skull films. In one of these patients the ventricles and subarachnoid spaces filled well and the cerebellar tumor was well demonstrated. In another, the first encephalogram showed downward herniation of the cerebellar tonsils and an immediate second lumbar injection of gas outlined the ventricular system and showed the cerebellar tumor. In 2 other cases traces of gas entered the lateral ventricles showing them to be enlarged following which an immediate ventriculogram was carried out and the 4th ventricle well shown in each. In none of the remaining 11 did the ventricles fill from below in spite of from one to three attempts, but in eight of the eleven some of the following abnormalities were shown: downward herniation of the cerebellar tonsils, elevation of

the callosal and/or cingulate sulci indicating hydrocephalus or marked flattening of the pontine cistern. The other 3 patients in whom the ventricles did not fill from below showed a normal appearance of the cisterns and sulci or else these spaces did not fill with gas. The 11 patients whose ventricles did not fill from below all had ventriculograms, 6 on the same day and 5 from 2 to 64 days later. In all eleven of these ventriculographies it was possible to fill the 4th ventricle. In none of the 15 patients having lumbar encephalograms were the neurological symptoms and/or signs increased by the encephalogram. For lumbar encephalography we allow very little cerebrospinal fluid to escape and keep the pressure as high or higher than the original pressure. We share the opinion that this tends to prevent downward displacement of the posterior fossa structures and tends to elevate any structures that have been depressed. We conclude that lumbar encephalography is of much less value than ventriculography in the diagnosis of cerebellar tumors, unlike cerebello-pontine angle tumors in which encephalography is the better procedure of the two. There are no oil ventriculograms in this series as we have never felt the necessity of such examinations. Of the 157 patients who had ventriculograms immediately after the conventional skull films, the 4th ventricle did not fill in sixteen. In 11 of these patients an immediate lumbar encephalogram was carried out. In none of these did the 4th ventricle fill from below but in most of them tonsillar herniation and/or flattening of the pontine cistern was shown. We believe that whenever a ventriculogram shows closure of the aqueduct of Sylvius a lumbar encephalogram will offer additional information. In such cases, if the 4th ventricle fills from below, the diagnosis is non-neoplastic stenosis of the aqueduct of Sylvius. If, however, the 4th ventricle does not fill from below a posterior fossa tumor is almost surely present. In some cases, such as cerebello-pontine angle tumors, the subarachnoid gas may outline the tumor allowing a localizing diagnosis to be made.

Filling and demonstrating the fourth ventricle. In the 157 patients who had ventriculograms immediately after the skull films, the 4th ventricle did not fill in sixteen and more than half of these were in the 1934 to 1945 group. We believe now that the 4th ventricle can be filled by ventriculography in posterior fossa tumors, even in cerebellar tumors in nearly all cases. After the ventricular fluid has been replaced by gas we make frontal and lateral films of the skull with the patient supine to show the anterior parts of the lateral and 3rd ventricles. The usual manoeuvers to fill the posterior 3rd ventricle, the aqueduct of Sylvius, and the 4th ventricle are then carried out and frontal and lateral films made with the patient prone to show these structures. The p. a. films

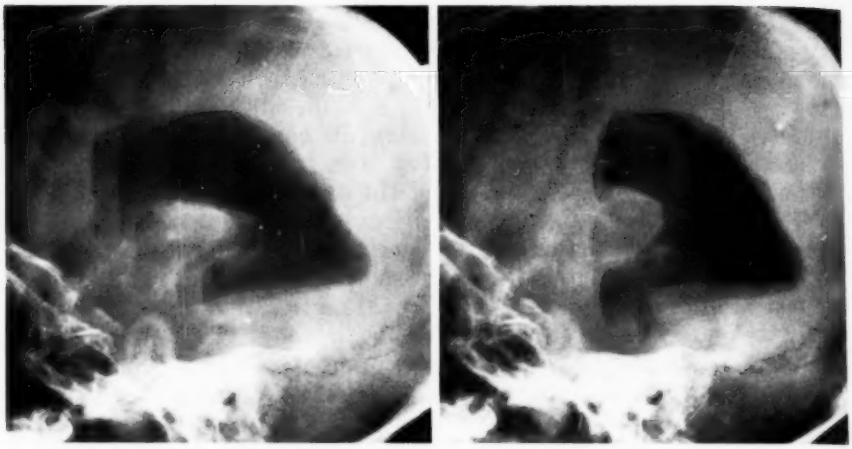

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Fig. 1.

a) Lateral view of skull, patient prone, showing gas in the third ventricle and in the aqueduct but none in the fourth ventricle.

b) Similar view after patient's head and body had been lowered for a few seconds. Fourth ventricle now contains gas and an intraventricular tumor of the fourth ventricle is visible.

B. W., male, age 8 years, medulloblastoma.

must be made in Granger or in reverse Towne projection to project the 4th ventricle above the base of the skull and above the frontal sinuses. The lateral films with the patient prone must be heavily exposed and must be in stereo. The ears must be bent forward and held in this position by adhesive tape so that there is no ear shadow over the 4th ventricle. If the 4th ventricle is seen in p. a. and not in lateral projection, then slightly oblique lateral films or lateral tomograms must be made to show the 4th ventricle from the side.

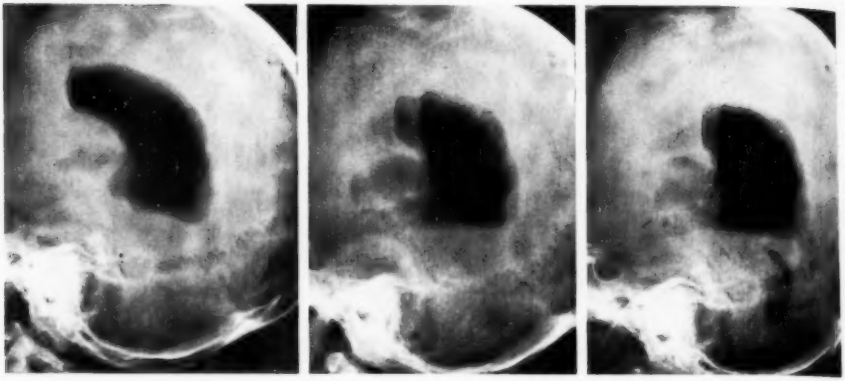
If these films show no gas in the 4th ventricle but show gas in the posterior part of the 3rd ventricle and the aqueduct of Sylvius the patient's body is lifted from the roentgen table and the head is depressed for a few seconds with the vertex almost touching the floor. The prone frontal and lateral films are then repeated and often show gas in the 4th ventricle (Fig. 1). If there is still little or no gas in the 4th ventricle the patient is told that his head is going to be jarred and he is asked not to hold himself stiffly. With the patient prone we support the forehead in our left hand and strike the side of the occiput a short sharp blow with the heel of the right hand. This results in a sudden rotation of the skull and seems to jerk the tumor enough to let a small amount of gas pass into the 4th ventricle (Fig. 2). In most cases it is not neces-

sary to jar the head so hard as to cause pain. We have never seen a bad effect from this manoeuver and in only one case did anything unusual happen. In one case the jarring opened up a cyst in one temporal lobe which had not previously been suspected.

Differentiation between tumor types

By choosing to deal with patients in the age group from birth to 15 years we were able to leave metastatic carcinomas, meningiomas and hemangioblastomas out of consideration. The congenital tumors such as dermoids nearly always show bony changes and the cerebellar abscesses nearly always show radiological signs of mastoid disease. The practical problem in an infant or child with a cerebellar tumor is to differentiate astrocytoma from medulloblastoma. The very rare conditions that might come into consideration, such as subarachnoid cyst, papilloma of the choroid plexus, and so on, require operation as they are not amenable to radiation therapy. The rest of this discussion will have to do with the radiological features of the 50 astrocytomas and the 54 medulloblastomas occurring from birth to the end of the 15th year in whom skull films and air studies are available for analysis. The apparent discrepancy in the figures is due to the fact that some of the patients had no roentgenograms at all and others had ordinary skull films but no air studies.

A. *Changes in the skull due to generalized increase in intracranial pressure.* We believe it is possible to grade pressure changes in the skull of infants and children and therefore speak of radiological signs of acute, subacute or chronic increase in intracranial pressure. In acute increase in intracranial pressure the cranial sutures widen if they can but this is the only abnormality. In subacute increase in intracranial pressure the sutures are widened but other changes are also present. If the edges of the bones are serrated (as they usually are after the age of 2 or 3 years) the serrations are longer than normal. Unfortunately the serrations vary in length from child to child and from age to age, wherefore this change is difficult to assess. There may be slight to moderate decalcification of the dorsum sella. The rest of the sella usually appears normal. The head is slightly enlarged. In chronic low grade increase in intracranial pressure the sutures are normal in width, the serrations of the sutures are usually normal in length, but the head is enlarged. The emissary vein openings are usually enlarged. The sella turcica is usually well calcified but may be enlarged. The chiasmatic groove of the sphenoid bone is often enlarged. The convolutional markings are broad and deep or else almost completely absent. There is, of course, some overlapping of the



a b c

Fig. 2. a) Lateral view of skull, patient prone, showing gas in the third ventricle but none in the aqueduct or fourth ventricle. b) Similar view after the head and body had been lowered for a few seconds. The aqueduct is now filled with gas. c) Similar view after jarring the head. The fourth ventricle is now filled and an intraventricular tumor is shown. L. M., female, age 3 1/2 years, astrocytoma of right cerebellar hemisphere.

subacute and chronic cases due to differences in the age at which the increased pressure appeared and to slight differences in the degree of increase in intracranial pressure. Enlargement of the skull in cases of arrested hydrocephalus can usually be differentiated from that due to cerebellar tumor because the skull is thicker and the brain markings less prominent and less generalized in arrested hydrocephalus.

The cranial sutures, although technically open in most youthful patients, may not be capable of widening because the serrations at their edges may interlock. Also it seems harder to widen sutures in thick skulls than in thin skulls. Therefore the coronal and sagittal sutures often cannot widen after middle childhood or roughly 5 to 10 years of age. In patients whose sutures cannot widen we can grade intracranial pressure changes only as acute and chronic. In early acute increase in intracranial pressure in older patients the anterior and/or superior cortex of the dorsum sella undergoes decalcification. Slightly later the floor of the sella turcica also loses calcium. Other changes such as decalcification of the lesser wings of the sphenoid bone, enlargement of the sella turcica, convolutional atrophy, and enlargement of the emissary vein openings, are signs of chronic increase in intracranial pressure.

Table 1 shows the results of radiological examination of the skull without contrast media in these patients. A normal appearance of the cranial bones was seen in only 6 out of 50 patients with cerebellar astro-

Table 1

Cerebellar tumors in children 1934 to 1955

Results of radiography without contrast media

	Cranial vault		Sutures		Sella turcica	
	Large	Convolutional atrophy	Wide	Elongated serrations	Dorsum eroded	Other changes
Astrocytoma	7	22	41	22	29	15
50 cases		(? —1)	(? —5)	(? —4)	(? —4)	
Medulloblastoma	1	8	31	7	14	10
54 cases		(? —3)	(? —5)	(? —3)	(? —3)	

cytomas. It was seen in 19 out of 54 patients with medulloblastomas, approximately three times as often. Signs of acute increase in intracranial pressure were seen twice as often in medulloblastomas (24 out of 54) as in astrocytoma (13 out of 50). Signs of subacute or chronic increase in intracranial pressure were seen much more often in astrocytomas (31 out of 50) than in medulloblastomas (7 out of 50). It was surprising how seldom chronic pressure changes were seen in medulloblastoma. For example in only 1 out of 54 medulloblastomas was the head enlarged. These results are probably due to the relatively rapid growth of most medulloblastomas and the relatively slow growth of most astrocytomas.

In the early examples we scored thinning and bulging of one side of the floor of the posterior fossa but found it to be an unreliable sign of cerebellar tumor and even an unreliable sign for determining on which side the tumor was situated. Asymmetry of the two sides of the floor of the posterior fossa is present in about 12 % of apparently normal people and in about 25 % of epileptic patients, so it is not very helpful.

B. *Intracranial calcification.* Tumor calcification was very helpful in differentiating cerebellar tumors of childhood. Well marked calcification in the tumor was seen in 8 of the 50 astrocytomas but in only 1 of the 54 medulloblastomas. Two other patients with astrocytomas showed questionable pathological calcification on the films. Incidentally, none of the ependymomas or hemangioblastomas showed pathological calcification, no matter the age.

In children with cerebellar astrocytomas a calcified pineal was seen in 4 and in none was it displaced. In the children with medulloblastomas the pineal was calcified in 3 and in 1 of these it was displaced upward 3 mm above the upper limits of normal.

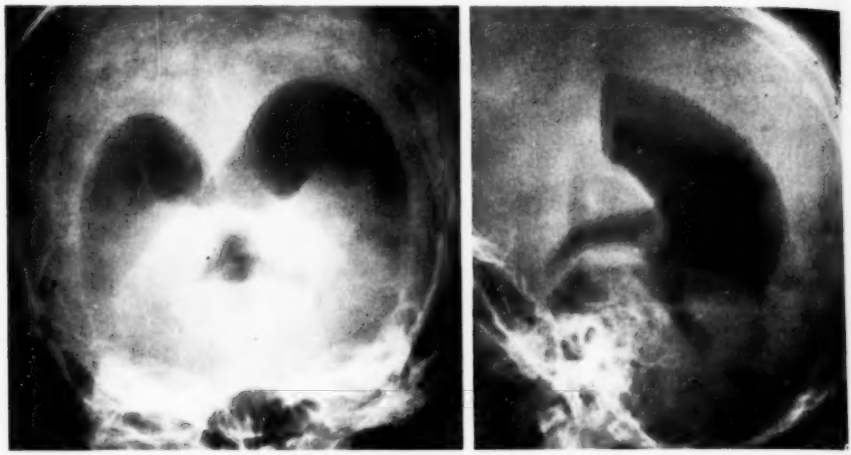


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Fig. 3. a) P. a. view and b) lateral view showing an irregular tumor mass within the fourth ventricle. R. Q., female, age 10 years, medulloblastoma.

C. *Deformities of the cisterns and sulci.* Downward herniation of the cerebellar tonsils and marked flattening of the pontine cistern were nonspecific changes seen in almost equal numbers of cerebellar astrocytomas and medulloblastomas. Downward displacement of the mamillary bodies was not seen but the interpeduncular and chiasmatic cisterns were filled in only 23 cases, so it cannot be said that downward displacement never occurs in cerebellar tumor. However since downward displacement of the mamillary bodies is so frequent in aqueduct stenosis and in tumors of the posterior part of the third ventricle demonstration of them may be of some localizing value.

Marked elevation of the callosal and cingulate sulci, evidence of marked enlargement of the lateral ventricles, favors the diagnosis of astrocytoma over medulloblastoma, as will be mentioned later, but the sulci are seen so seldom in patients such as these that this is of little practical value.

D. *Deformities of the fourth ventricle.* In 1939 LYSHOLM (2) said that sometimes tumors within the 4th ventricle could be outlined by air and 'if the tumor surface is irregular the most probable diagnosis is papilloma, if smooth medulloblastoma or ependymoma'. This has not been our experience. We found many irregular tumor masses projecting into the 4th ventricle in cerebellar astrocytoma and medulloblastoma but much

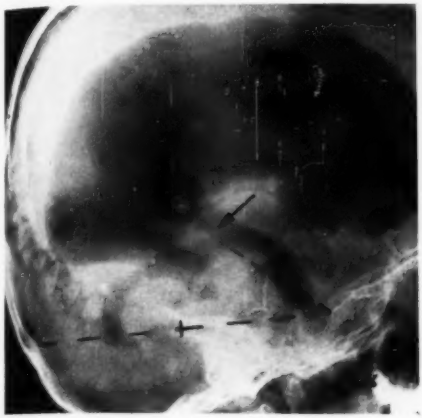

Fig. 4. Lateral view showing Twining's line and a line from the tuberculum sellae to the junction of the aqueduct and the third ventricle. Irregular soft tissue mass in the fourth ventricle. G. P., male, age 6 years, astrocytoma.

more often in the latter (Fig. 3). It is difficult to decide when there is an actual mass in the 4th ventricle if the mass is not irregular in outline. A smooth intraventricular mass often produces the same picture (Fig. 5) as a cerebellar hemispheral tumor that is displacing the 4th ventricle laterally.

We found Twining's line to be very valuable in assessing slight displacements of the 4th ventricle. The centre of Twining's line from the tuberculum sella to the internal occipital protuberance, corresponds fairly well with the center of the 4th ventricle in normal individuals. Occasionally the floor of the 4th ventricle is at the center of Twining's line but if the floor of the 4th ventricle is displaced behind the center of Twining's line a pontine, pre-pontine or cerebello-pontine angle tumor is almost surely present. If the roof of the 4th ventricle is anterior to the center of Twining's line, then a cerebellar tumor is almost surely present. If the fastigium is more than 1 cm above or below Twining's line, a tumor in the corresponding area should be strongly suspected.

The fourth ventricle is enlarged in many cerebellar tumors, most often in the intra-ventricular ones. This may not have been appreciated because the fourth ventricle has not been air-filled in many of these patients. It is especially obvious if successive ventriculograms are done during the course of roentgen treatment.

Table 2 shows that an intraventricular mass with an irregular surface is much more common in medulloblastoma than in astrocytoma. The demonstration of any other deformity of the 4th ventricle, whether it be called a displaced 4th ventricle or a smooth intraventricular mass, was of no differential value. Incidentally, 2 of the 3 children with posterior fossa ependymoblastoma and ependymoma showed an irregularly outlined mass in the 4th ventricle.

In many of the cases of inferior 4th ventricle tumor a small upward herniation of the upper part of the roof of the 4th ventricle was seen. It was slightly more common in medulloblastoma than in astrocytoma but not of significant degree. At ventriculography gas passed through

Table 2

Cerebellar tumors in children
Deformities of the fourth ventricle

	No filling	Intra-ventricular mass		Lateral shift
		Irregular	Smooth	
Astrocytoma				
45 cases	5	4	21	15
Medulloblastoma				
51 cases	6	25	13	7

the 4th ventricle into the cisterna magna in 15 patients with astrocytoma and in 17 patients with medulloblastoma suggesting that the degree of obstruction of the 4th ventricle was the same in each condition.

E. *Deformities of the aqueduct and 3rd ventricle.* The plane of the aqueduct relative to Reid's base line was measured on lateral films and in a majority of cases it was horizontal, that is, parallel to the base line (23 cases of astrocytoma, 30 cases of medulloblastoma). The plane of the aqueduct was normal, that is, approximately 45° to Reid's base line, in 18 cases of astrocytoma and in 19 cases of medulloblastoma.

It was difficult to decide when there was elevation of the aqueduct and of the posterior part of the floor of the 3rd ventricle. The relationship of these structures to the temporal horns (1) and to the angles described by various authors (5), (6), (8) varied considerably. The greatest variation is seen in infants in whom the posterior part of the 3rd ventricle is sometimes very high even when there is no tumor and no hydrocephalus. The floor of the posterior part of the 3rd ventricle is higher in brachycephalic skulls than in dolichocephalic. We became convinced that Twining's line from the tuberculum sella to the internal occipital protuberance was of some value here also. We measured the angle between Twining's line and a second line from the tuberculum sella to the beginning of the floor of the aqueduct or to the habenular commissure (Fig. 4). We found it to be increased in 34 of 44 cases of astrocytoma in which it could be measured, and increased in 30 of 49 cases of medulloblastoma. This angle varied from 12° to 34° in a small number of normal individuals in whom it was measured and we considered any angle over 35° to be an increased angle, implying elevation of the posterior part of the floor of the 3rd ventricle.

One patient with medulloblastoma of the 4th ventricle, proved histologically, showed an irregular soft tissue mass on the anterior part of the floor of the 3rd ventricle which we assumed to be a secondary medulloblastoma.

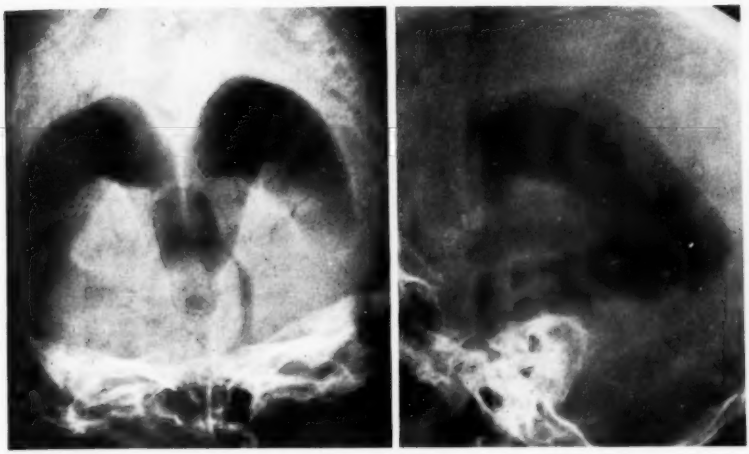

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Fig. 5. a) P. a. view and b) lateral view showing a smooth tumor mass in the fourth ventricle. J. G. C., male, age 9 years, medulloblastoma.

F. *Changes in the lateral ventricles.* The lateral ventricles were dilated in nearly all of the patients. The degree of dilation was estimated by taking the height of the bodies of the lateral ventricles at their smallest point in the middle of the body of the lateral ventricle. It was measured on lateral films made at a 40-inch (100 cm) focal film distance with the patient prone or supine. We considered any measurement above 10 mm as indicating enlargement. Any measurement of 30 mm or more was considered to be evidence of marked enlargement and any measurement of 50 mm or more was considered evidence of extreme enlargement. There were 25 patients with marked enlargement of the lateral ventricles in the 50 astrocytoma patients. There were 17 patients with marked enlargement in the 54 patients with medulloblastomas. Six patients with astrocytoma showed extreme enlargement of the lateral ventricles but only one patient with medulloblastoma showed this change.

Small degrees of asymmetry of the lateral ventricles and small shifts of the septum pellucidum were seen frequently in ventriculograms and usually indicated that the pressures in the lateral ventricles had been unequal during the ventriculography. There were significant localized deformities of the lateral ventricles in 6 patients. In 2 astrocytoma patients the floor of the trigone on the same side as the cerebellar tumor was elevated, probably indicating unilateral elevation of the tentorium. A similar change was seen in 3 medulloblastoma patients. In 1 astro-

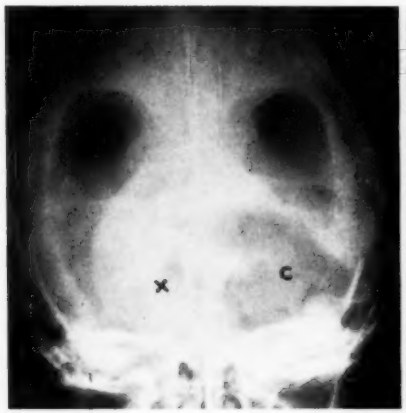

Fig. 6. P. a. view showing a left cerebellar cyst partly filled with air. C = cyst; X = fourth ventricle. D. L., female, age 2 1/2 years, astrocytoma.

Fig. 7. P. a. view showing a midline cerebellar cyst and mural nodule. The fourth ventricle is not filled. The two metal clips are attached to the upper part of a ventriculo-peritoneal tube. G. L., female, age 14, medulloblastoma.

cytoma patient the tumor had invaded the midbrain and the posterior part of the thalamus on the same side producing focal deformities of one lateral ventricle and of the 3rd ventricle as well as of the 4th ventricle.

G. *Presence or absence of cerebellar cyst.* The presence or absence of a cerebellar cyst cannot be inferred from the ventriculogram or encephalogram unless the cyst wall should rupture during the procedure and allow the cyst to fill with gas. We have never seen this happen. However, during biopsy of cerebellar tumors, cysts are frequently encountered and may be shown radiologically (Figs. 6 and 7). They are about five times more frequent in astrocytomas than in medulloblastomas. The exact frequency cannot be given as it is difficult to tell whether a few drops of fluid coming through the biopsy needle indicate a small cyst or indicate the fourth ventricle.

Conclusions

Cerebellar tumors in children from birth to age 15 years are usually astrocytomas or medulloblastomas. The only other lesions that may be confused with these are ependymomas, ependymoblastomas, papillomas of the choroid plexus and subarachnoid cysts but these are exceedingly rare. In posterior fossa dermoid cysts and in cerebellar abscesses there are usually characteristic changes in the bone or in the mastoids which will remove these lesions from consideration.

In the differentiation of cerebellar astrocytomas and medulloblastomas the following points are of some importance.

Normal skull films favor the diagnosis of medulloblastoma.

Skull changes due to chronic increase in intracranial pressure, and especially enlargement of the skull, favor the diagnosis of astrocytoma.

Calcification of the tumor favors the diagnosis of astrocytoma.

Demonstration of an intraventricular tumor mass with an irregular surface favors medulloblastoma.

Extreme enlargement of the lateral ventricles favors astrocytoma.

Acknowledgement

This work was assisted by a grant from the James Picker Foundation for radiological research.

SUMMARY

The authors state that cerebellar tumors in children in ages from birth to 15 years are usually astrocytomas or medulloblastomas. The only other lesions that may be confused with these are ependymomas, ependymoblastomas, papillomas of the choroid plexus and subarachnoid cysts but these are exceedingly rare. The differential diagnosis of cerebellar astrocytomas and medulloblastomas is discussed.

ZUSAMMENFASSUNG

Die Verfasser konstatieren, dass Kleinhirntumore bei Kindern, von Neugeborenen bis zu 15 Jahre, gewöhnlich Astrocytome oder Medulloblastome sind. Die einzigen Veränderungen, die sonst mit diesen verwechselt werden können, sind Ependymome, Ependymoblastome, Papillome des Plexus chorioideus und subarachnoidale Zysten. Diese Veränderungen sind jedoch ausserordentlich selten. Die Differentialdiagnose zwischen Kleinhirnastrocytomen und Medulloblastomen wird diskutiert.

RÉSUMÉ

D'après les auteurs, les tumeurs cérébelleuses de l'enfant, de la naissance à 15 ans, sont habituellement des astrocytomes ou des médulloblastomes. Les seules autres tumeurs qu'on peut confondre avec ceux-ci sont des épendymomes, des épendymoblastomes, des papillomes du plexus choroïde et des kystes sous-arachnoïdiens mais ils sont excessivement rares. Les auteurs étudient le diagnostic différentiel des astrocytomes et des médulloblastomes cérébelleux.

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CITÉ HOSPITALIÈRE DE LILLE, HÔPITAL RÉGIONAL, SERVICE DE RADIOLOGIE OUEST
(DIRECTEUR: G. BONTE), LILLE, FRANCE

ANGIOGRAPHIE VERTÉBRALE PAR CATHÉTÉRISME RÉTROGRADE FÉMORAL

par

G. Bonte, G. Riff et *E. Spy*

Depuis l'époque où Egaz MONIZ pratiqua les premières encéphalographies artérielles les progrès de la radiologie vasculaire ne se mesurent plus. Si les modalités et les indications de l'angiographie carotidienne sont actuellement bien au point, il n'en est pas tout à fait de même de l'angiographie des vaisseaux de la fosse postérieure qui présente de plus en plus d'intérêt pour le neurologue et le neurochirurgien. Ses indications et les exigences de sa technique lui donnent une place à part dans le domaine de l'artériographie cérébrale.

La multiplicité des techniques proposées jusqu'à ce jour, tant par dénudation, ponction directe, ou cathétérisme rétrograde, semble bien mettre en évidence qu'aucune n'est encore pleinement satisfaisante.

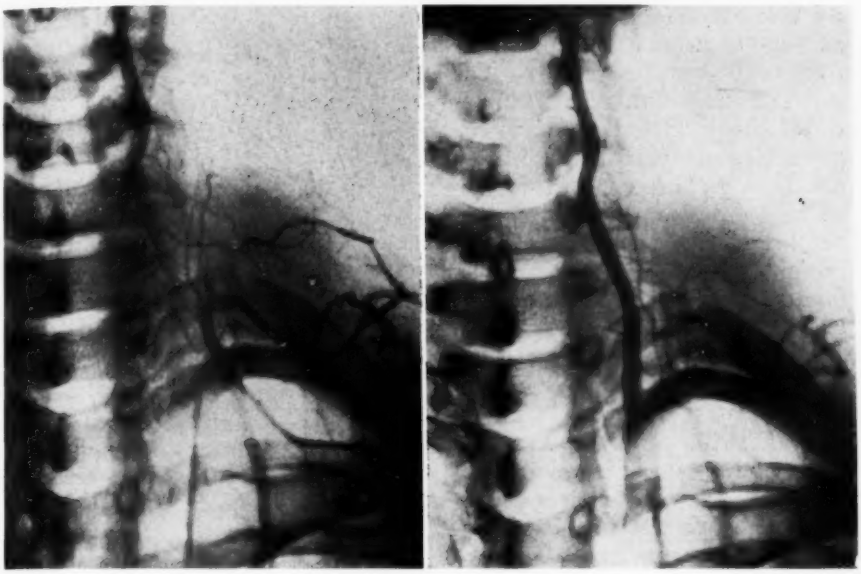
En France la préférence va aux techniques de ponction directe, soit par voie cervicale haute de LINDGREN, soit par la voie inter-occipito-atloïdienne de MASLOWSKI diffusée par PETIT-DUTAILLIS et NAMIN. Par contre, les techniques par cathétérisme sont très en faveur dans les pays Scandinaves, où celle mise au point par RADNER recueille la plupart des suffrages. Dernièrement au Symposium de Neuro-Radiologie de Londres, LINDGREN proposait une nouvelle technique d'angiographie vertébrale par cathétérisme rétrograde de la fémorale.

Fig. 1. Angiocardiographie au temps gauche, face et profil simultanée, montrant la disposition anatomique la plus fréquente de l'insertion des vaisseaux de la crosse. L'aorte descendante, la sous-clavière gauche et l'aorte vertébrale sont en continuité directe.

Cette proposition a retenu notre attention et nous nous sommes attachés cette dernière année à voir les possibilités de cette technique.

En effectuant des aortographies thoraciques avec l'instrumentation de SELDINGER, nous nous étions aperçus que très souvent le cathéter montait directement dans l'artère sous-clavière gauche au lieu de suivre la courbure de la crosse aortique. Revoyant nos dossiers d'angiocardiographie intra-veineuse et d'aortographie thoracique, nous nous sommes rendus compte combien était fréquente la disposition anatomique favorable qui permettait ce cathétérisme. En effet, le plus souvent sur le cliché de face, la sous-clavière gauche est exactement dans l'axe de l'aorte descendante, elle se situe à peine en avant de l'axe de celle-ci sur la radiographie de profil. Aussi nous fûmes tentés d'utiliser systématiquement le cathétérisme de l'aorte thoracique pour effectuer les angiographies vertébrales des services de Neurologie (Prof. P. NAYRAC) et Neurochirurgie (Prof. E. LAINE) du C. H. R. de Lille, à l'Hôpital St-André.

Actuellement environ 75 angiographies vertébrales ont été réalisées par cette voie et les examens ont été pratiqués chez des sujets dont l'âge allait de 6 à 70 ans. Si au début nous avons pratiqué presque systématiquement l'angiographie vertébrale dans la recherche des processus expansifs



a b

Fig. 2. Clichés pris au cours d'un cathétérisme. a) L'injection porte surtout sur le tronc thyro-bicervico-scapulaire et sur la mammaire interne. b) La sonde est retirée, puis engagée vers la vertébrale.

de la fosse postérieure concurremment avec l'encéphalographie gazeuse fractionnée et la ventriculographie, nous avons par la suite limité ses indications aux malades dont l'histoire clinique ou les examens paracliniques permettaient de soupçonner une malformation vasculaire.

Préparation. Dans les heures qui précèdent l'examen le malade sera soumis à une médication analgésique banale qui s'est toujours révélée suffisante tant pour le confort du malade que celui de l'opérateur. Jamais nous n'avons eu recours à l'anesthésie générale.

Quand l'âge et l'état vasculaire du sujet incitent à la prudence, une perfusion de sérum papavériné et scurocaïné est mise en oeuvre dans les jours qui précèdent.

Technique. La méthode consiste à introduire par voie fémorale, au niveau de l'arcade crurale, un cathéter de polythène enfilé sur un mandrin métallique, que l'on pousse dans l'aorte thoracique jusqu'au niveau de la crosse aortique en le suivant sous radioscopie.

Pour cela nous utilisons l'instrumentation ingénieuse de SELDINGER qui permet d'introduire sans dénudation un cathéter de calibre identique

au trocart de ponction. Pour les raisons anatomiques que nous avons exposées plus haut il arrive souvent que le cathéter emprunte directement l'artère sous-clavière gauche, mais parfois il suit la courbure de la crosse aortique, à ce moment des manoeuvres de va et vient, avec modification de l'orientation du cathéter, en le faisant tourner sur son axe, sont effectuées.

Si ces manoeuvres se révèlent infructueuses, le bras gauche du malade est relevé vers la tête, ce qui suffit souvent à faire pénétrer le cathéter dans la sous-clavière.

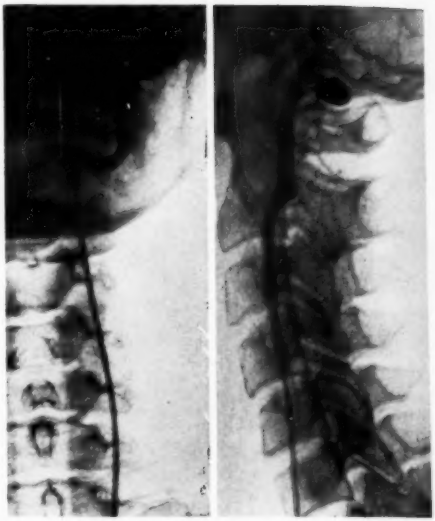


Fig. 3. Pénétration directe du cathéter dans l'artère vertébrale jusqu'à la deuxième cervicale.

Si ce résultat n'est pas obtenu, d'autres manoeuvres sont successivement tentées: hyperextension de la tête et du rachis cervico-dorsal ou, au contraire, hyperflexion.

Une fois introduite dans la sous-clavière la sonde emprunte fréquemment le tronc thyro-bicervico-scapulaire, il est alors nécessaire de retirer le cathéter, l'orifice de la vertébrale étant situé bien en deçà; de nouvelles manoeuvres de va et vient du cathéter, accompagnées de rotation et l'inclinaison latérale de la tête, facilitent l'introduction du cathéter et de son mandrin dans la vertébrale, où on le monte de quelques centimètres pour éviter le déplacement et surtout le recul du tube de polythène quand on retirera le mandrin métallique. Pour vérifier l'absence de déplacement du cathéter au cours de ces manoeuvres, on pratique un cliché repère en injectant quelques centimètres cubes de contraste. Il est certain que ces manoeuvres de pénétration du cathéter dans l'artère vertébrale pourraient être facilitées par l'emploi de cathéters spéciaux mis au point par Ödman: cathéters radiopaques dont il est possible de modifier la courbure suivant le vaisseau recherché. Mais nous n'avons pas encore eu l'occasion de les utiliser, n'ayant pu nous les procurer.

La plupart de nos réussites ont été obtenues par injection dans la vertébrale elle-même. À plusieurs reprises n'ayant pu atteindre la vertébrale, nous avons tenté l'injection à l'orée de la sous-clavière et malgré l'emploi de contraste à concentration plus élevée, deux fois seulement l'opacification des branches intra-craniennes de la vertébrale se révéla

satisfaisante. Le cathétérisme de l'artère vertébrale elle-même nous semble donc indispensable.

En cas d'insuccès des différentes manoeuvres, qui permettent de l'obtenir, nous ne prolongeons pas l'examen à l'excès par de nouvelles tentatives, ce qui risquerait d'enlever à la méthode le bénéfice de son innocuité.

Le cathétérisme étant obtenu, on effectue six clichés en incidence frontale et six clichés en incidence sagittale, en pratiquant chaque fois l'injection de 8 ml d'un contraste triodé à grosses molécules: Vasurix 25, (Guerbet).

Résultats

L'opacification de l'artère vertébrale, après cathétérisme rétrograde de l'aorte thoracique, a été tentée chez 75 malades dont l'âge moyen se situe aux environs de la quarantaine. Des clichés interprétables des vaisseaux de la fosse postérieure ont pu être obtenus chez 45 de ces malades, ce qui représente un pourcentage de succès de 60 %.

Ces 45 succès se répartissent de la façon suivante:

23 pénétrations directes dans la vertébrale gauche.

1 pénétration directe dans la vertébrale droite; il s'agissait d'une malformation lusoria de l'arc aortique par naissance à gauche de la sous-clavière droite.

19 pénétrations dans la sous-clavière, puis secondairement dans la vertébrale après différentes manoeuvres.

2 injections à l'orée de la sous-clavière.

Les 30 échecs sont dûs aux causes suivantes:

Dans 3 cas il était impossible de pénétrer dans l'aorte à cause de sinuosités anormales des fémorales ou des iliaques.

Dans 12 cas le cathéter a simplement suivi la crosse aortique sans entrer dans aucune de ses branches. Il s'agissait sans aucun doute dans ce cas d'une disposition anatomique moins fréquente que nous montrent nos angiocardiographies, où la sous-clavière émerge très en dedans et très en avant sur le sommet de la crosse.

Dans 15 cas le cathéter montait dans la sous-clavière et dans certaines de ses branches, en particulier le tronc thyro-bicervico-scapulaire, mais jamais nous n'avons pu l'introduire dans la vertébrale.

Dans tous les cas où l'opacification de la vertébrale a pu être obtenue la qualité des clichés nous a semblé au moins égale à celle des clichés

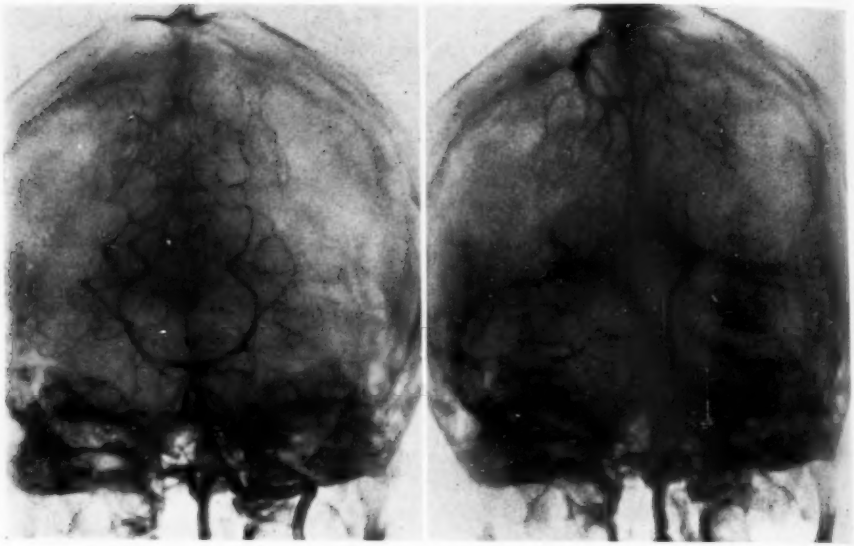


Fig. 4. Angiographie vertébrale par cathétérisme fémoral dans un cas de petit hématome du cervelet. Au temps artériel s'observe un soulèvement et une tension des cérébrales postérieures qui restent symétriques sur la face. Le tronc basilaire est plaqué sur le clivus.

obtenus par ponction, la richesse et le contraste des temps phlébographiques étant nettement supérieurs.

Accidents et règles d'innocuité. Les accidents peuvent survenir aux différents temps de la méthode; les difficultés du cathétérisme sont les raisons qui pourraient augmenter les risques de l'examen par rapports aux méthodes habituelles, or quelle que soit la technique employée les accidents sont identiques et surviennent lors de l'injection ou immédiatement après.

Le spasme, beaucoup moins fréquent que par ponction, a été rarement rencontré mais a cédé à l'injection de spasmolytiques sans laisser de séquelles décelables.

Trois accidents ont du être déplorés. Aucun d'eux ne nous a semblé être sous la dépendance du cathétérisme lui-même, mais au contraire sous celle de l'injection du contraste; dans un cas l'opacification avait été tentée alors que le cathéter n'avait pu être introduit dans la sous-clavière et dans les autres cas des injections trop répétées avaient été réalisées. Dans un de ces cas il semble d'ailleurs que l'examen aurait du être évité, étant donné l'âge du sujet et la fragilité vasculaire dont il avait déjà fait preuve.

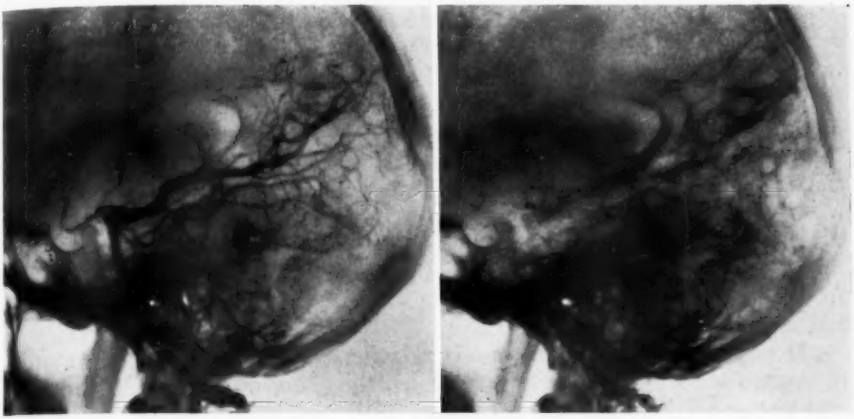


Fig. 5. Les phlébogrammes sont particulièrement riches, la disposition des vaisseaux y est normale.

L'innocuité de l'examen exige donc des règles de sécurité bien précises auxquelles il est indispensable de se conformer:

rapidité du cathétérisme par une technique bien au point;

emploi de contraste à faible concentration pour réduire au minimum son action irritante;

utilisation d'une quantité minime de contraste sous faible pression, 15 ml sont amplement suffisants pour réaliser les deux incidences;

l'espacement des injections qui évite l'apparition de phénomènes de toxicité par sommation sur lesquels BROMAN a insisté;

enfin, une préparation minutieuse est une garantie supplémentaire dans la prévention du spasme et de phénomènes réflexes malencontreux.

Avantages. Nous voudrions maintenant rappeler rapidement les points sur lesquels la méthode nous a paru marquer un avantage par rapport aux méthodes habituelles par ponction.

La technique en est plus facile et il faut certes moins d'habilité pour ponctionner une grosse artère superficielle comme la fémorale, que pour trouver la vertébrale dans le canal transversaire et surtout y rester. Moins pénible, plus confortable pour le malade, elle lui évite l'anesthésie générale.

Le cathéter étant en place, l'opérateur a toute latitude pour installer le malade dans la position qui lui convient le mieux et les clichés pouvant être développés avant d'enlever le cathéter, d'autres incidences peuvent être obtenues très facilement. On n'est plus limité dans ce cas que par la quantité totale de contraste que le malade peut supporter sans inconvénient.

Cette méthode, en supprimant tout dommage de la paroi artérielle, écarte le danger d'une injection périvasculaire douloureuse, ne gêne pas la mobilisation du malade et facilite considérablement la réalisation des différentes incidences radiologiques.

Mais il nous semble que l'avantage primordial de cette technique soit l'injection pratiquée à distance qui supprime tout danger d'irradiation pour l'opérateur. En effet, dans la ponction cervicale, même si l'on parvient à protéger parfaitement les mains de l'opérateur contre le rayonnement direct, il est extrêmement difficile d'éviter complètement tout rayonnement secondaire. Ceci revêt une importance extrême étant donné la fréquence de plus en plus grande vers laquelle ces examens sont aujourd'hui demandés.

Il ne faut pas cependant que la relative facilité de la méthode semble la mettre à portée d'opérateurs incompétents qui en méconnaîtraient les dangers et les limites. Elle doit être l'object d'une collaboration étroite entre neurologue, neurochirurgien et radiologiste qui, n'en ignorant pas les risques, sont à même de les prévenir et d'y remédier.

Conclusions

Au cours de l'aortographie thoracique par cathétérisme rétrograde fémoral, nous avons pu constater que très fréquemment le cathéter se dirige dans l'orifice de la première branche de la crosse aortique qu'on rencontre, l'artère sous-clavière gauche. Nous avons recherché si cette particularité reposait sur une base anatomique suffisante pour envisager son emploi dans l'opacification de vaisseaux de la fosse postérieure.

La pratique de plus de 75 examens nous a montré que le cathétérisme de l'artère vertébrale était possible et aisé dans la grande majorité des cas, et que ce procédé, que laissait envisager LINDGREN au dernier Symposium de Londres, pourrait entrer dans la pratique courante d'un service de Neuro-radiologie.

Les résultats sont aussi satisfaisants que ceux obtenus par ponction transcutanée, beaucoup moins bien tolérée par le malade, exigeant un opérateur plus entraîné, mais surtout exposant les mains de celui-ci à une irradiation dangereuse.

Cet examen a été pratiqué chez nous sans anesthésie, même chez l'enfant, en utilisant l'instrumentation de SELDINGER, poussant le cathéter sous le contrôle de la radioscopie, dans la vertébrale, jusqu'au niveau de C3, des manoeuvres d'hyper-extension du tronc et du cou facilitant son passage dans la sous-clavière et dans la vertébrale. L'injection dans la sous-clavière, sans cathétérisme vertébral, ne donne pas de résultats suffisants.

Des échecs proviennent, soit d'une sinuosité anormale des iliaques qui ne permet pas le cathétérisme, soit d'une disposition anatomique inhabituelle des vaisseaux de la crosse. La technique d'injection percutanée est alors utilisée. Le cathéter étant en place, les radiographies peuvent être prises dans toutes les positions et sous toutes les incidences, en toute tranquillité, faisant courir le minimum de risques au malade et épargnant à l'opérateur toute irradiation dangereuse.

Pour une exploration dont les indications augmentent sans cesse, il n'est pas sans intérêt de connaître un nouveau procédé qui, s'il ne donne pas plus que les autres de succès absolu, présente sur eux certains avantages.

RÉSUMÉ

Les auteurs pratiquent systématiquement l'angiographie vertébrale par cathétérisme à partir de la fémorale. Ils ne recourent à la technique par ponction directe qu'en cas d'insuccès du cathétérisme. Celui-ci est possible chez la plupart des sujets, grâce à la continuité presque directe de l'aorte descendante, de la sous-clavière gauche et de l'artère vertébrale. Ce procédé à l'avantage de ne pas nécessiter l'anesthésie générale, même chez l'enfant, de donner beaucoup de facilités à la technique radiographique et surtout d'éviter toute irradiation des mains de l'opérateur.

SUMMARY

The authors perform vertebral angiography by catheterization of the femoral artery. The method is usually successful owing to the fact that the descending aorta, left subclavian artery, and vertebral artery lie more or less in a straight line. The direct puncture technique is reserved for those few cases in which catheterization fails. The procedure has the advantages that general anaesthesia is unnecessary, even in children, that it facilitates the roentgenographic technique, and above all that irradiation of the hands of the operator is avoided.

ZUSAMMENFASSUNG

Die Verfasser führen in allen Fällen die Vertebralisangiographie durch Katheterisierung der Arteria femoralis aus. Die direkte Punktionstechnik wird nur dann angewendet, wenn die Katheterisierung nicht gelungen ist. Letztere ist bei den meisten Patienten möglich, da die Aorta descendens, die Arteria subclavia sinistra und die Arteria vertebralis nahezu eine gerade Linie bilden. Die Prozedur hat folgende Vorteile: Narkose ist, auch bei Kindern, nicht notwendig, die röntgenologische Technik ist viel leichter und vor allem wird jede Bestrahlung der Hände des operativ arbeitenden Radiologen vermieden.

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AUS DER PATHOLOGISCHEN ABTEILUNG (LEITENDER OBERARZT: PROF. LAAS) UND DER RÖNTGENABTEILUNG (CHEFARZT: PROF. BÜCKER) DES ALLGEMEINEN KRANKENHAUSES HEIDBERG, HAMBURG, DEUTSCHLAND

PATHOLOGISCH-ANATOMISCHE UNTERSUCHUNGSERGEBNISSE AN DER ARTERIA CAROTIS NACH PERKUTANER GEFÄSSPUNKTION UND IHRE KLINISCHE BEDEUTUNG

von

A. Rimpau und *H. Seils*

In mehr als 200 Fällen wurden systematische Untersuchungen an Hand von histologischen Serienschnitten der Punktionsstelle nach perkutaner Carotispunktion ausgeführt. Die Zeitspanne zwischen der Punktion und der Untersuchung betrug wenige Stunden bis zu einem Jahr.

Nach einer frischen Punktion findet man an der Intima einen Querriß von 1 bis 3, manchmal auch bis zu 5 mm Länge. Ein Fall wurde beobachtet, bei dem dieser Riß mehr als die Hälfte des Gefäßumfanges betrug. Die Ränder sind leicht abgehoben und unterminiert, wobei sie meist etwas in das Gefäßinnere hineinragen. Auffallend ist im Stichbereich ein Zurückweichen der quer verlaufenden Mediafasern, das in den mittleren Mediaschichten am stärksten in Erscheinung tritt. In Laufe der Heilung schrumpfen die Stichwunden zu kleinen Kratern mit einem erhabenen Randwall und sehen dann ähnlich wie Gefäßabgänge aus. Später wird die Einziehung flacher, doch ein kleiner Wall mit einem hellen Saum bleibt immer bestehen.

Die frischen Stichkanäle in der Gefäßwand verschließen sich durch einen fibrinreichen Gerinnungspfropf, der oft weit bis in die Adventitia

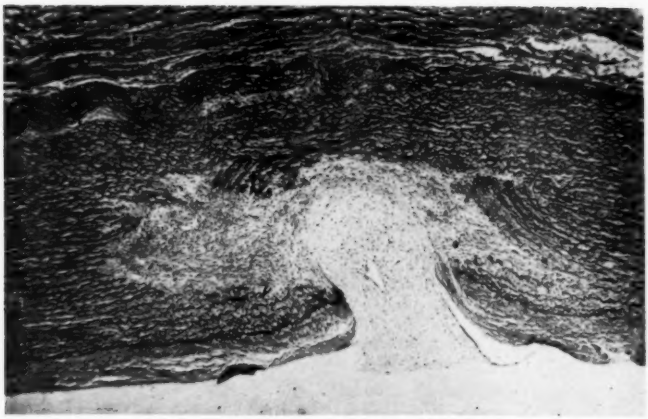

Abb. 1. 52-jähr. Mann. Narbe nach Arterienpunktion vor 6 Wochen; das unterschiedliche Zurückweichen der Mediafasern ist auch im Narbenstadium deutlich. (Elastica-Van Gieson, Vergrösserung 38 ×.)

Abb. 2. 39-jähr. Mann. Kleines Wandhämatom in der Arteria carotis comm. 6 Wochen nach Arteriographie. (Hämat.-Eosin, Vergrösserung etwa 10 ×.)

reicht, aber niemals über die Intima hinaus in das Gefäßinnere vorspringt. Hervorzuheben ist besonders, daß niemals Thromben oder Reste von Thromben an diesen Stellen zu finden waren. Später wuchern Zellen in diesen Fibrinpfropf ein und nach ungefähr einem Monat hat sich ein zellreiches Bindegewebe gebildet, das zum Schluß zu einem elastinreichen Gewebe umgebaut wird, wobei es jedoch nicht zu einer Annäherung der Stichkanalränder kommt (Abb. 1).

In etwa 99 % der untersuchten Fälle konnte eine Durchstechung des Gefässes festgestellt werden, so daß man eine Ein- und eine Ausstichstelle finden kann, die sich meist in ihrer Größe etwas unterscheiden.

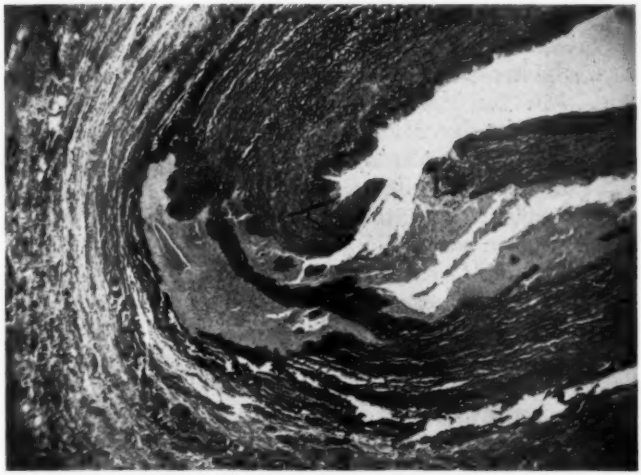

Abb. 3. 54-jähr. Gröbere Wandverletzung einer Arterie, wahrscheinlich durch mehrfaches Punktieren. (Elastica-Van Gieson, Vergrösserung 36 ×.)

Abb. 4. 51-jähr. Frau. Kleines sackförmiges Aneurysma an 4 Wochen alter Arteriographiepunktionsstelle. (Elastica-Van Gieson, Vergrösserung etwa 12×.)

In der Regel ist der Einstich größer als der Ausstich. Öfter liegen beide Stichstellen nahe beieinander, wenn das Gefäß nicht in der Richtung seines Durchmessers durchstochen wurde und gelegentlich war auch ein Konfluieren von Ein- und Ausstichverletzung festzustellen, wenn das Gefäß tangential getroffen wurde. Es entsteht dann eine bedeutend größere rißartige Wandverletzung.

Nicht so selten, nämlich in 8 % der Fälle, konnte ein Wandhämatom gefunden werden, das teils von der Einstich- teils von der Ausstichstelle seinen Ausgang genommen hatte. Die Stichstelle findet sich immer am Rande, niemals in der Mitte des Hämatoms. Die Mediafasern werden dabei überwiegend in der Mittelschicht aufgespalten und ein Teil der Gefäßwand wird durch das Hämatom abgehoben (Abb 2). Diese Abhebung springt dann polsterartig in das Gefäßlumen vor. Teilweise konnte man diese Vorwölbungen von Linsen- bis Erbsengröße schon makroskopisch erkennen, wobei dann auch die Einengung des Gefäßinneren deutlich wurde. In 3 Fällen war dieser Befund so ausgedehnt, daß es zu einer sehr weitgehenden, vielleicht sogar vollständigen Verlegung des Gefässes gekommen sein mußte. In diesen Fällen zeigten sich regelrechte, scheidenförmige dissezierende Aneurysmen, die sich von der Stichstelle aus weiter cranial- oder caudalwärts ausdehnten. Manchmal ist die Media dabei in mehrere Schichten aufgespalten (Abb. 3 und 4).

Wenn gröbere Blutungen zu beobachten waren, so fiel auf, daß in diesen Fällen eine Verletzung der V. jugularis vorlag, so daß geschlossen werden kann, daß eine Stichverletzung der Vene in erster Linie für die Blutungen in die Umgebung verantwortlich zu machen ist. Der Blutaustritt aus der Arterie scheint dagegen viel geringer zu sein und nimmt nur bei Wanddissektionen größere Ausmaße an. In unserem Material ist es niemals nötig gewesen, wegen einer Nachblutung operativ einzugreifen, außer in einem besonders gelagerten Falle, der kurz dargestellt werden soll. Dabei war nach Beendigung des arteriographischen Eingriffs die Nadel schwungvoll entfernt worden, doch war dieses Herausziehen nicht in der Stichrichtung erfolgt. Dadurch hatte die Nadelspitze das Gefäßrohr an einer Stelle in der Längsrichtung regelrecht aufgeschlitzt.

Die Gefahr bedrohlicher Nachblutungen besteht auch bei antithrombotischer Behandlung und natürlich in Fällen von Hämophilie.

Vereinzelt wurden noch Befunde erhoben, bei denen man an der Gefäßwand Defekte sehen konnte. Ein kleines Wandstück war regelrecht aus seiner Umgebung herausgestanzt. Möglicherweise läßt sich dieser Befund durch mehrfache Punktionen oder durch ein Entlangschaben mit der Kanülenspitze an der Gefäßinnewand erklären.

Aus den hier vorgelegten anatomischen Befunden läßt sich einerseits erkennen, daß der Organismus die Verletzungen einer Arterie nach Punktionen recht gut zur Heilung und Vernarbung bringen kann, doch sollte andererseits auch daran gedacht werden, daß gerade im Bereich der Carotis Komplikationen möglich sind, die nicht ganz bedeutungslos bleiben. Bekannt sind aus der Literatur vereinzelte Mitteilungen von Zwischenfällen mit z. T. tödlichem Ausgang, deren Ursache sich eindeutig an der Punktionsstelle der Carotis finden ließ.

Dagegen könnten die Wandhämatome, die mit ihrer Strombahneinengung zu einer verminderten Durchblutung am Gehirn führen, und die wir in unserem Material regelmäßig und nicht so selten nachweisen konnten, für Verschlechterungen des Krankheitsbildes und für eine Zunahme von neurologischen Ausfallerscheinungen verantwortlich sein, die bisher auf eine andere Art erklärt wurden. Daraus ergibt sich die Forderung, die Punktion sachgemäß und möglichst schonend auszuführen, was natürlich weitgehend von der Erfahrung und Geschicklichkeit des Untersuchers abhängt.

Folgende Punkte sollen dazu kurz herausgestellt werden:

1. Es muß zur Punktion eine geeignete Kanüle ausgewählt werden. Die Stärke derselben soll sich nach dem Gefäßkaliber richten (Geschlecht, Konstitution, Alter des Patienten) und darf nicht zu dick gewählt werden. Wichtig ist die Art des Schliffs an der Kanülenspitze: die Abschrägung soll relativ kurz und steil sein (LINDGREN), auf jeden Fall aber müssen die Ränder scharf sein, weil sonst leichter die Möglichkeit besteht, daß die Mediafasern sich infolge stärkerer Beschädigung weit retrahieren, wodurch einem Einbluten in die Wand Vorschub geleistet wird. Die eigentliche Nadelspitze soll möglichst spitzig ausgearbeitet sein, damit man ein bei der Punktion zur Seite ausweichendes Gefäß leichter anstechen kann.

Auf die Vor- und Nachteile der verschiedenen Spezialkanülen soll an dieser Stelle nicht weiter eingegangen werden.

2. Die tangentiale Durchstechung der Arterie mit Bildung einer größeren schlitzartigen Verletzung soll man durch eine geeignete Punktionstechnik möglichst zu vermeiden suchen.

3. Mehrfache Punktionen an der gleichen Stelle sind ebenfalls zu vermeiden.

4. Eine gewisse Bedeutung für die Ausbildung eines Wandhämatoms scheint der intramuralen Injektion zuzukommen. Liegt nach der Punktion die Nadelöffnung nicht völlig frei im Gefäßlumen, sondern z. T. noch in der Wand, so kommt es zwar zu einem pulsatorischen Blutrückstrom aus der Nadel. Kehrt sich jedoch die Strömungsrichtung bei der Injektion um, so infiltriert die eingespritzte Flüssigkeit die Gefäßwand, die kissenartig aufquillt und sich dabei vor die Nadelöffnung legt. Als Folge davon hört der Blutrückstrom aus der Nadel auf. Ehe man also zu einer Kontrastmitteleinspritzung unter stärkerem Druck schreitet, muß man erst sorgfältig prüfen, ob die Kanülenöffnung auch völlig frei in der Arterie liegt.

Da die Lichtung der A. carotis interna bedeutend kleiner ist, als die der Communis, müssen sich Einengungen durch Wandhämatome im Bereich der Interna weit stärker auf die Blutdurchströmung auswirken.

Deshalb ist von einer Punktion der Carotis interna im allgemeinen abzuraten.

Zum Schluß soll noch erwähnt werden, daß durch Gefäßmißhandlungen aller Art bei einer Punktion auch Spasmen im Bereich der Carotis begünstigt werden können.

ZUSAMMENFASSUNG

Es werden anatomische und histologische Befunde mitgeteilt, die bei serienmäßigen Untersuchungen an Carotis-Punktionsstellen erhoben werden konnten. Die Aufmerksamkeit soll besonders auf die gefundenen Wandhämatome gelenkt werden, die bei entsprechender Größe sicher zu einer Strombahneinengung führen. Komplikationen, die von der Punktionsstelle ihren Ausgang genommen haben, sind bisher nur vereinzelt bekannt geworden, doch wird die Frage diskutiert, ob nicht später auftretende Verschlimmerungen des Krankheitsbildes ihre Ursache in einer Gefäßwandschädigung mit Strombahneinengung haben können.

SUMMARY

The anatomical and histologic findings in a large material of carotid puncture sites are presented. The significance of haematomas in the walls is emphasized and it is pointed out that these, if sufficiently large, inevitably lead to occlusion of the lumen. Complications having their origin at the puncture site have so far been encountered only occasionally but the question is raised as to whether a subsequent deterioration in the clinical condition might not be caused by injury to the vessel wall and occlusion.

RÉSUMÉ

Les auteurs présentent les constatations anatomiques et histologiques qu'ils ont faites sur une grande série d'examens du lieu de ponctions carotidiennes. Ils soulignent l'importance des hématomes qu'ils ont trouvés dans les parois de ce vaisseau et insistent sur le fait que, s'ils sont assez volumineux, ils doivent inévitablement entraîner l'occlusion de la lumière carotidienne. On n'a constaté qu'occasionnellement des complications ayant leur origine au lieu de ponction, mais les auteurs posent la question de savoir si une aggravation de l'état clinique à la suite d'une ponction carotidienne ne pourrait pas être due à la lésion de la paroi du vaisseau et à son occlusion.

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT (DIRECTOR: POUL E. ANDERSEN)
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THE LENTICULO-STRIATE ARTERIES AND THEIR DIAGNOSTIC VALUE

A preliminary report

by

Poul E. Andersen

Following the increasing neurologic and neurosurgical demands in recent years for an exact roentgenologic localization and delineation of an intracerebral lesion, small vessels, such as the anterior choroidal and posterior choroidal arteries and the deep cerebral veins, have increased in importance. Furthermore, in diseases such as parkinsonism, exact angiographic evaluation of the arteries supplying the basal ganglia and the internal capsule has become of considerable value. These arteries, which are appropriately called the lenticulo-striate arteries, have been mentioned only occasionally in most textbooks on cerebral angiography, and they are usually shown incorrectly (FISCHER, ECKER, KRAYENBÜHL, ORLEY).

The present investigation was inspired by this inconsistence between the illustrations in textbooks of the so-called normal anatomy and angiography and actual routine angiographic findings. It consisted in an attempt to evaluate these arteries and their possible diagnostic value in an unselected material of 300 consecutive carotid angiographies.

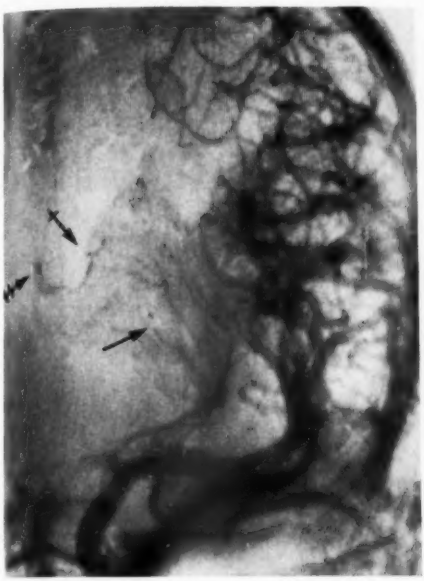
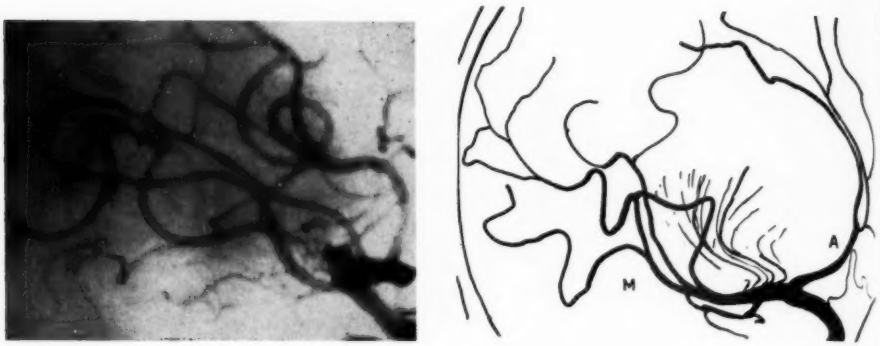


Fig. 1. Angiography. Normal course of lenticulo-striate arteries (→) medial to ascending part of middle cerebral artery with capillary filling to the floor of the lateral ventricle and filling of the thalamo-striate vein (↠) and internal cerebral vein (⇻).

Normal angiography

The arteries to the basal ganglia, the lenticulo-striate arteries, were investigated by HEUBNER, BEEVOR, AITKEN, SHELLSHEAR, and GODINOV, among others. Most anatomists divide the arteries which arise from the first part of the middle cerebral artery into two sets. The medial striate arteries pass upwards through the anterior perforate substance and the globus pallidus of the lentiform nucleus and the internal capsule, to end in the body of the caudate nucleus. The lateral striate arteries pass upwards through the putamen or between it and the external capsule and often divide into two terminal collections of arteries: the anterior lenticulo-striate, and a posterior lenticulo-optic collection of fine arteries. All these traverse the lentiform nucleus and the internal capsule and terminate near the floor of the lateral ventricle. The capillaries are drained by the thalamostriate vein and its tributaries. One of the lenticulo-striate arteries which passes in the first instance around the lateral side of the lentiform nucleus and afterwards through its substance, is larger than its companions and is the well-known 'artery of cerebral hemorrhage'. The lenticulo-striate arteries are usually drawn as running vertically and finally bending a little medialwards or streaming upwards as a tuft of fine vessels, a pattern which may in effect be seen only in certain rare pathologic conditions.

The normal angiogram of these vessels was determined primarily in cases in which a space-occupying, neoplastic, vascular, or atrophic lesion had been excluded by a clinical investigation, and by pneumography and electroencephalography; the patients usually suffered from hemicrania or epilepsy. The normal course in the a. p. view is shown in Fig. 1. The course of the lenticulo-striate arteries in this view is as follows. The origin from the carotid system occurs from a region 13 to 15 mm in length in the upper and posterior part of the middle cerebral artery, on an



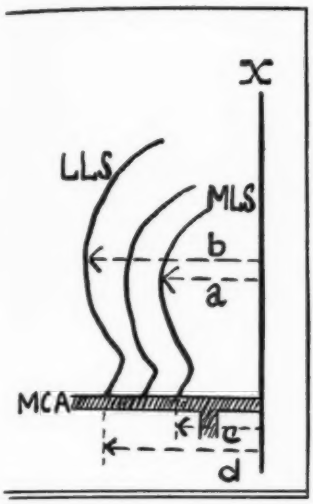
a b

Fig. 2. a) Fine lenticulo-striate arteries partly concealed by ramifications of middle cerebral artery. b) Fan of lenticulo-striate arteries between the anterior (A) and middle (M) cerebral arteries.

average between about 17 and 30 mm from the midplane, which varies a little according to the size and shape of the skull. The most medial of the lenticulo-striate arteries may arise from the carotid siphon at the bifurcation of the anterior and middle cerebral arteries and in an exceptional case even from the anterior cerebral artery when the bifurcation is situated far laterally (not to be mistaken for the anterior choroidal artery or the artery of HEUBNER).

In one case the lenticulo-striate arteries arose by two wide branches situated far laterally and which ran medially for several millimeters and then divided fan-like, and, presumably on entering the anterior perforate substance, continued their course in the usual way. In a few cases we have noticed that the medial group of lenticulo-striate arteries have arisen in a single trunk which ran medially, almost parallel to the middle cerebral artery and, from its upper aspect, gave off branches which eventually followed the normal course.

From its origin the artery at first always runs medially and upwards for a few millimeters, usually 3 to 5, then bends rather sharply in a curve upwards and outwards, and finally terminates just under the floor of the lateral ventricle in close relation to the origin of the thalamostriate vein. If the head of the patient is tilted a little backwards during the angiography the first part of the lenticulo-striate arteries may be almost concealed behind the middle cerebral artery. When the tube is tilted 15° to 20° cranially with the base line of the skull vertical, the central beam is usually perpendicular to the main course of the lenticulo-striate arteries as seen in the lateral view (Fig. 2 a). The upper part of the course is fan-like with



Table

Distance from midline of skull to most lateral point on the convexity of the curve of the most medial and the most lateral of the lenticulo-striate arteries lying in the arterial fan

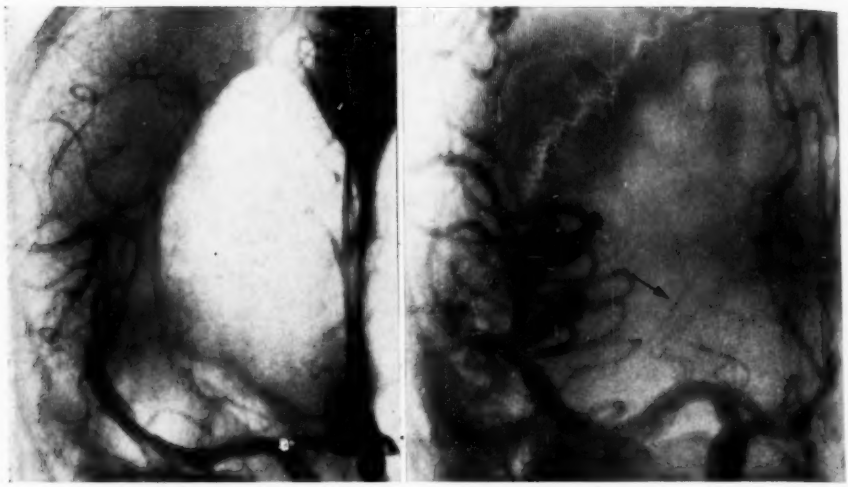
Distances	Normal	Cases	
		Central atrophy	Cortical atrophy
a.....	26 mm	29 mm	27 mm
b.....	38 »	39 »	34 »
c.....	17 »	—	—
d.....	30 »	—	—

X—midplane.
MLS—most medial lenticulo-striate artery.
LLS—most lateral visible lenticulo-striate artery.
MCA—middle cerebral artery.

the arteries spreading towards the convex floor of the lateral ventricle and the caudate nucleus. We also usually find a fan-like distribution with the arteries running in a slight backward and downward curve. The first part of the course, especially of the posterior lenticulo-striate vessels, may in some cases be similar to that seen in the a. p. view with the arteries at first running horizontally backwards for a few millimeters, then bending upward in a rather sharp knee and finally continuing in the usual manner. In some cases the oblique view (see Fig. 2 b) may furnish an excellent view of the lenticulo-striate arteries distributed over a large part of the area between the anterior and middle cerebral arteries.

The diameter of the lenticulo-striate arteries is rather small; in old subjects they are often only just visible and any movement of the patient's head, even one so slight as not to affect other vessels, may blur these arteries. Complete fixation of the head is essential. The injection of the usual 4 to 6 ml of contrast medium is sufficient to show the arteries; if the injection is a little protracted a filling or faint contrast loading of the ganglia is often obtained in the capillary phase and this gives an excellent delineation of the floor of the lateral ventricle and may demonstrate internal atrophy (Fig. 1).

An attempt was made to measure the course of the lenticulo-striate arteries by calculating in the a. p. view the distance from the midline of the skull to the most lateral point of the convexity on the curve of the most medial and the most lateral of the lenticulo-striate arteries



a b

Fig. 3. a) Considerable displacement and depression of lenticulo-striate arteries in a case of hydrocephalus. Accentuation of the knee of the most medial vessels. b) Intracerebral hematoma. Typical course of the first part of the lenticulo-striate arteries (→) with compression well shown.

lying in the arterial fan. These points were considered to be the most fixed and reliable ones and unchanged by any tilting in the sagittal plane. In normal cases, as many as 7 or 8 vessels may sometimes be discernible, but only 4 or 5 clearly visible; in atrophic conditions only 3 to 4 vessels can usually be defined. The average distances are given in the Table on opposite page. The variations were only small in normal cases, especially when correlated to the width of the skull as a percentage.

Atrophic conditions

In 46 cases of atrophy (17 with diffuse external atrophy and 29 with internal atrophy, mixed cases and localized atrophies being omitted) the figures were different, as shown in the table. (The distances *c* and *d* show no alteration in cases of atrophy, while there is some change in space-occupying lesions depending upon their situation.) In normal cases distance *a* usually amounts to 31 % to 32 % of the distance between the midplane and inner lamina of the skull, while distance *b* is 47 % to 48 %. In cases of internal atrophy the figures are about 37 % and 50 % respectively, while cases of external atrophy show percentages of 33 % to

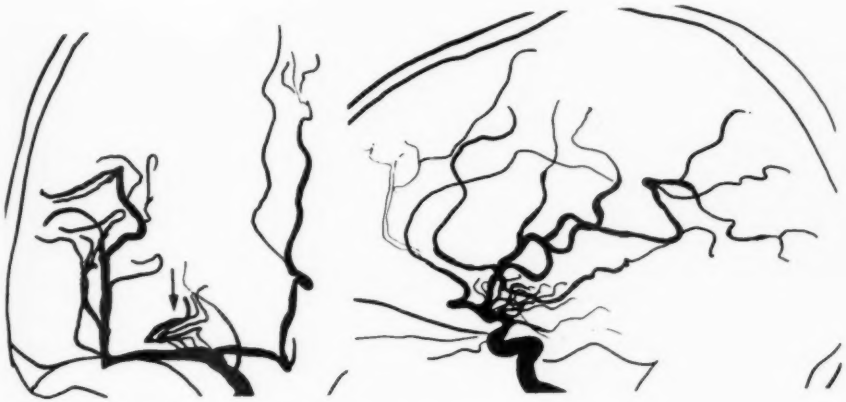


Fig. 4. Typical findings in a deep-seated tumour.

34 % and of 43 % respectively. There is, of course, a biologic spreading of the figures, but the figure *a* in particular has proved constant; when this distance *a* is more than one-third of that between the midplane and inner lamina the probability of internal atrophy is considerably increased.

In elderly subjects the average number of visible lenticulo-striate arteries decreases, and/or they become more difficult to see and are thinner. The upper medial parts of the arteries in particular seem to disappear, and the filling tends to be maximal a little later than in young people.

Space-occupying lesions

In most cases of space-occupying lesions, especially in deep-seated tumours and hematomas, the lenticulo-striate arteries are characteristically displaced and deformed, depending upon their situation. These arteries may then furnish excellent information as to the size, site and, perhaps, character of the lesion (see Fig. 3 a).

The following few examples illustrate the changes in cases of hematomas and tumours.

Fig. 3 b shows a case of hemorrhage in the internal capsule, from angiography of a 41-year-old woman with hypertension. The day before the angiography she became excited and had a fit with paresis of the left extremities. At operation a hematoma, about 120 ml in volume, was evacuated.

Fig. 4 is from a case of a deep-seated tumour, the situation of which was demonstrated by the compression of the lenticulo-striate arteries. Almost the only change in the other intracranial vessels was the slight elevation of the anterior part of the middle cerebral artery in the lateral view.

Fig. 5 is from a case of a 30-year-old woman with an inoperable tumour lying deep in the fronto-basal region. Removal was attempted, but within 4 months the signs reappeared, and the angiograms as well as encephalograms showed a mass lateral to the site of the tumour which had been removed; she died a few weeks later. The full lines indicate the course of the lenticulo-striate arteries on first admission, while the broken lines map the greatly altered course on the second admission, the anterior cerebral and middle cerebral arteries being almost unchanged.

We have thus found the lenticulo-striate arteries to be helpful in the diagnosis of atrophic conditions and of definite value in the localization and delineation of intracerebral tumours as well as of intracerebral hematomas in the internal capsule or arising from ruptured angiomas. Atrophy may in many cases be inferred with reasonable confidence from simple measurements in the a. p. view. It may be expected that further roentgenologic investigations of these arteries will produce further data of value for diagnostic purposes. It is our intention to devote our next effort to changes in cases of tumours in various situations.

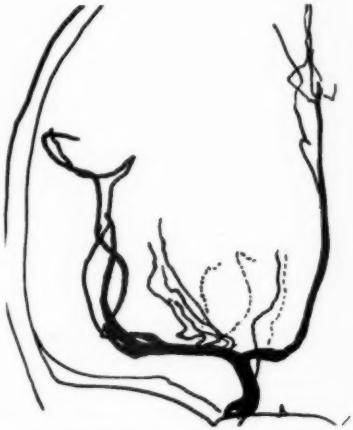


Fig. 5. Case of deep-seated fronto-basal tumour. Full lines: Prior to operation. Broken lines: Course of lenticulo-striates and anterior choroidal artery at time of recurrrence.

SUMMARY

A short survey is given of the lenticulo-striate arteries with special reference to the appearances at angiography and the changes which occur in atrophic and space-occupying lesions.

ZUSAMMENFASSUNG

Es wird kurz über die lenticulo-striaten Arterien, ihren normalen Verlauf und die charakteristischen Veränderungen bei atrophischen und raumerfordernden Prozessen berichtet.

RÉSUMÉ

L'auteur décrit brièvement l'aspect angiographique normal des artères lenticulo-striées et leurs modifications dans les lésions atrophiques ou tumorales.

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NEUROLOGISCHE KLINIK DER MASARYK UNIVERSITÄT IN BRNO, TSCHECHOSLOWAKEI

DIE DARSTELLUNG DER ARTERIA CEREBRALIS POSTERIOR BEI DER KAROTISANGIOGRAPHIE UND IHRE DIAGNOSTISCHE BEDEUTUNG

von

B. Chrást und *B. Vágner*

Es gibt, wie allgemein bekannt ist, zwei Wege zur arteriographischen Darstellung der Hirngefässe, nämlich den karotidealen und den vertebralen Weg. Eine gewisse Grenzstellung zwischen diesen beiden Versorgungsgebieten des Gehirns bildet die A. cerebralis posterior. Sie füllt sich regelmässig bei der Vertebralisangiographie, sie füllt sich aber auch in einem gewissen Prozentsatz der Karotisangiographien. Gerade solchen Fällen wollen wir unsere Aufmerksamkeit widmen.

Früher wurde der Bedeutung der A. cerebralis posterior bei der Bewertung der karotisangiographischen Bilder wenig Beachtung gewidmet. In der letzten Zeit haben schon manche Autoren auf diesen Mangel hingewiesen.

Wir suchten von unserem arteriographischen Material technisch einwandfreie, gut dargestellte und auswertbare Bilder aus um zu sehen wie oft A. cerebralis post. bei der Karotisangiographie dargestellt wird, und ob es sich dabei um Ausnamen oder irgendwelche Gesetzmässigkeiten handelte. Wir versuchten auch eine Auffassung von dem Wert der Darstellung der A. cerebralis posterior zu erhalten.

Die cerebrale Arteriographie wird meistens nicht unter normalen Zirkulations- und Druckverhältnissen im Innern des Schädels gemacht.

Sie wird hauptsächlich bei Verdacht auf raumbeengende Hirnprozesse im weitesten Sinne des Wortes duchgeführt, ferner bei vaskulären Erkrankungen und bei symptomatischen Epilepsien, also unter pathologischen Umständen. Deshalb können die Resultate zu welchen wir gekommen sind keine absolute Gültigkeit haben.

Bei 600 Patienten fanden wir die A. cerebralis post. in 114 Fällen dargestellt, davon 4 Fälle nur in der a. p. Projektion, 73 Fälle nur in seitlicher und 37 Fälle in beiden Projektionen. Es wird also, unseren Erfahrungen nach, die A. cerebralis post. in 18.9 % der Karotisangiographien dargestellt. Diese Darstellung wird hauptsächlich in den lateralen Projektionen gefunden.

In den meisten Fällen trat die Füllung über die A. communicans post. ein. In 29 Fällen aber — das entspricht 25.2 % — zeigte sich die A. cerebralis post. als direkter Ast der inneren Halsschlagader und entsprang zwischen dem Abschnitt C1 und C2 des karotischen Syphons (nach der Nomenklatur von FISCHER). Als Beweis für die direkte Abzweigung dienten uns 3 Kriterien: 1) Der Abschnitt, welcher der A. communicans post. entspricht, verläuft gerade oder nur in flachem Bogen, 2) kein "Knopf" zwischen diesem und dem weiteren Verlauf der A. cerebralis post., und 3) kein wesentlicher Unterschied im Lumen des Gefässes zwischen diesen beiden Abschnitten.

Am öftesten findet sich die A. cerebralis post. bei Tumoren des Temporallappens oder bei in dessen unmittelbarer Nähe liegenden Geschwülsten dargestellt. Ist sie ein direkter Ast der A. carotis interna, so füllt sie sich regelmässig wie andere Hauptäste der Karotis. Bei indirekter Füllung mittels der A. communicans post. liegt der Hauptgrund für die Darstellung in der Veränderung des hämodynamischen Gleichgewichtes zwischen dem System der A. carotis interna und dem der A. vertebralis.

Supratentoriale Hemisphärengeschwülste verändern durch ihren Druck auf den karotischen Syphon und auf seine Äste das hämodynamische Gleichgewicht zugunsten der A. basialis. Spritzt man unter solchen Umständen das Kontrastmittel in die Halsschlagader so gelangt dieses — wegen des Widerstandes im Versorgungsgebiet der Karotis interna — in die A. communicans post. und durch diese in die A. cerebralis post. leichter als unter normalen Verhältnissen. Dadurch entstandener relativer Überdruck in der A. basialis wirkt dabei helfend. Wegen des Widerstandes im Versorgungsgebiet der A. carotis interna strömt das Blut der A. basialis ausgiebiger in die A. cerebralis posterior und reisst das Blut aus der A. communicans post. mit. Dieser Saugmechanismus der A. basialis kombiniert sich also mit dem Weichen-artigen Mechanismus der A. carotis interna. Bei reichlich vaskularisierten Geschwülsten und bei vaskulären Malformationen akzeptieren wir völlig den Aspirationsmechanismus von Scarcella.

Die grösste diagnostische Bedeutung der bei der Karotisangiographie dargestellten A. cerebralis post. sehen wir dort, wo die Veränderungen an der A. cerebralis ant. und media wenig ausgeprägt sind. Eine Verdrängung des distalen Abschnittes der A. cerebralis post. über die Mittellinie in der a. p. Projektion ist ein pathognomisches Zeichen einer umfangreicheren Geschwülst des Okzipitallappens; wir haben sie zweimal beobachtet.

Aber auch der Veränderung der Konfiguration der vorderen Teile der A. cerebralis post. ist eine grosse diagnostische Bedeutung beizumessen. Als Basis für die Beurteilung einer kranio-kaudalen Verschiebung der ersten zwei Abschnitte der A. cerebralis post. an der seitlichen Projektion wählten wir die Linie Nasion — Processus alae parvae. Eine Depression unter diese Linie deutet mehr auf eine Lokalization im Temporallappen. Eine Medialverschiebung der ersten zwei Abschnitte in der a. p. Projektion weist auf die Gefahr einer Mittelhirneinklemmung hin.

Diagnostisch wichtig ist auch die Beziehung der A. cerebralis post. zu der sylvischen Gruppe in der lateralen Projektion und zur A. cerebralis ant. in der a. p. Projektion. Im ersten Falle ist die Dissoziation der sylvischen Gruppe und der A. cerebralis post. ein wichtiges Zeichen für die Anwesenheit von Temporaltumoren. Die A. cerebralis post. bildet in solchen Fällen die untere und die A. cerebralis media die obere Backe der Zange, welche die Geschwulst einschliesst. Nähert sich dagegen die sylvische Gruppe der A. cerebralis post. so spricht das mehr zugunsten der Lokalization im Parietallappen.

Die A. cerebralis post. wird bei der Karotisangiographie nur selten dargestellt — etwa in 20 % der Fälle. Wenn es aber zu ihrer Darstellung kommt, so ist diesem Umstand eine grosse diagnostische Bedeutung beizumessen.

ZUSAMMENFASSUNG

Die Frekvenz der Darstellung der A. cerebralis posterior ist von den Verfassern in einem Material von 600 Angiographien untersucht worden. In 114 Fällen, d. i. in etwa 19 %, war die Arteria gut dargestellt, und am öftesten bei Gehirngeschwülsten, besonders bei solchen des Temporallappens. Bei solchen Fällen wo die Dislokation der Arteria cerebralis anterior und media minimal und unsignifikant ist, hat die Darstellung der Arteria cerebralis posterior an den carotischen angiographischen Bildern eine grosse diagnostische Bedeutung.

SUMMARY

The authors have examined carotid angiograms of 600 patients with cerebral disease. The posterior cerebral artery was clearly visible in 114 cases, *i. e.* in about 19 % of the material. It was most frequently demonstrated with brain tumours especially of the temporal lobe. A demonstration of the posterior cerebral artery is of great diagnostic value, especially in such cases where the displacement of the anterior and middle cerebral arteries is insignificant.

RÉSUMÉ

Les auteurs ont étudié la fréquence de la visualisation de l'artère cérébrale postérieure sur une série de 600 angiographies. Dans 114 cas, c'est-à-dire dans environ 19 % des cas, cette artère était bien visible et le plus souvent dans les cas de tumeur cérébrale, en particulier dans celles du lobe temporal. La visualisation de l'artère cérébrale postérieure sur les clichés d'angiographie carotidienne a une grosse valeur diagnostique dans les cas où le déplacement des artères cérébrales antérieure et moyenne est minime et non significatif.

AUS DER RÖNTGENABTEILUNG (LEITER: PRIVATDOCENT K. DECKER) DER UNIVERSITÄTSNERVENKLINIK (DIREKTOR: PROF. K. KOLLE), MÜNCHEN, DEUTSCHLAND

VERSCHLÜSSE DER ARTERIA CEREBRI MEDIA

von

Alfred Breit

Einen Verschluss der mittleren Hirnarterie zu diagnostizieren, fällt leicht, wenn man ein typisches Seitenbild sieht. Man wird weiter versuchen, die Lage des Gefässverschlusses anzugeben: ob er nahe an der Teilungsstelle der Arteria carotis gelegen ist oder etwas weiter distal. Auch über die Ausdehnung des Collateralkreislaufes kann man vielleicht in einem Serienangiogram Aufschluss geben; wenngleich auch aus einer guten Ausbildung des Collateralkreislaufes nicht Schlüsse auf die klinische Prognose gezogen werden können.

Schwierig werden die Verhältnisse erst dann, wenn man versucht, Gefässverschlüsse im Bereich der Äste der Media zu diagnostizieren. Abb. 1 gibt über unsere Beobachtungen bis zum 1.1.1957 Auskunft. Auf 69 Verschlüsse der Arteria carotis interna am Halse entfallen 40 entsprechende Beobachtungen am Hauptstamm der Media, während die Zahl der Astverschlüsse demgegenüber nur 9 beträgt. Gleichzeitig sind auf der vorliegenden Aufnahme die nach unserer Erfahrung häufigsten Lokalisationen der proximalen Astverschlüsse festgehalten.

Aus dieser geringen Zahl wird man schliessen können, dass es schwierig ist, entsprechende Beobachtungen im Angiogramm zu sichern. Allein die Vielfalt der möglichen Teilung der Gefässe verdient hier Berücksichtigung. Ausserdem hat zweifellos auch die jeweilige Richtung des

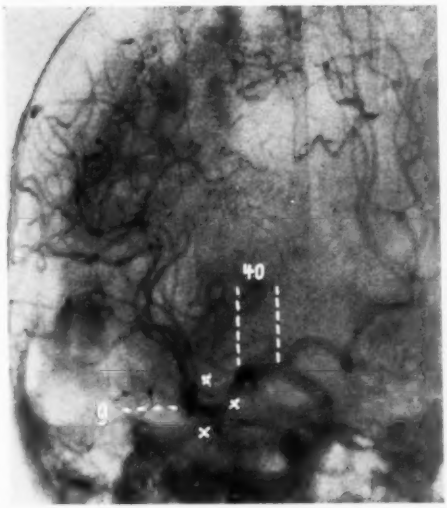

Abb. 1. Typische Lokalisationen der Mediaverschlüsse.

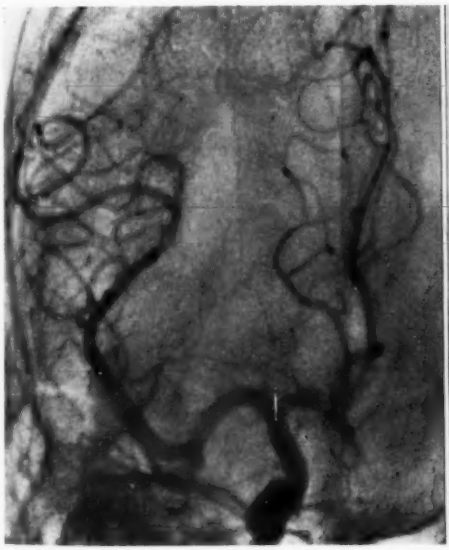

Abb. 2. Zweiteilung der Media.

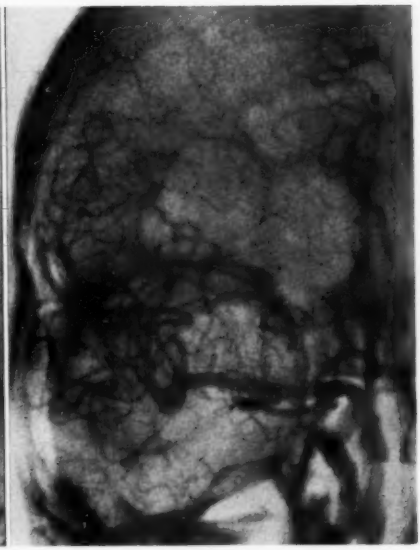

Abb. 3. Dreiteilung der Media.

Zentralstrahles eine grosse Bedeutung. Um die peripheren Äste besser einsehen zu können, ist es zweckmässig, eventuell stärker gekippte Vorder-bilder anzufertigen oder eventuell in einer Zusatzaufnahme eine leichte Drehung des Schädels durchzuführen.

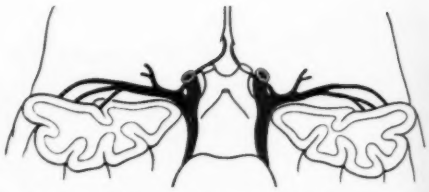

Abb. 4. Schema der normalen Mediateilung.

Zwei wesentliche Typen der Gefässverteilung können wir nach unseren anatomischen Studien unterscheiden: entweder eine Zwei- oder eine Dreiteilung des arteriographischen Gefässbildes.

Im Gefässbild (Abb. 2) ist eine Zweiteilung der Arteria cerebri media demonstriert. Der verbleibende Hauptstamm teilt sich später wieder.

Die Abbildung 3 zeigt, dass auch bereits in der Inselregion eine Teilung in 3 Endäste stattfinden kann. Eine schematische Zeichnung gibt über diese Verhältnisse der normalen Mediateilung Aufschluss (Abb. 4).

Einige pathologische Fälle seien hier angeführt. Es ist nicht immer so, dass man bei einer etwas abnormen Teilung nahe des Ursprungs der mittleren Hirnarterie einen Gefäßstumpf erkennen kann. In diesen Fällen ist die Diagnose einfach. Man kann hierbei überrascht sein, wie ausgedehnt der Ausfall im Seitenbild ist. In dem hier gezeigten Fall ist

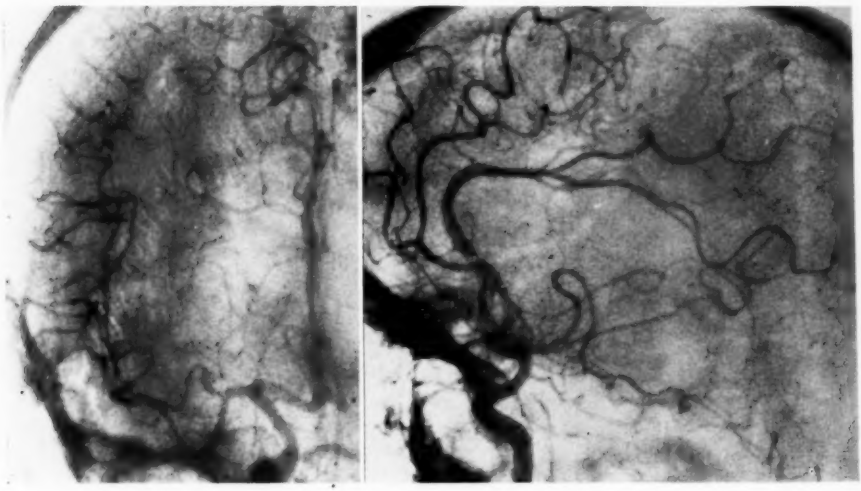

Abb. 5. Mediaverschlüsse mit erhaltener Kandelaberarterie.

Abb. 6. Mediaverschluss mit erhaltener Arteria temporalis.

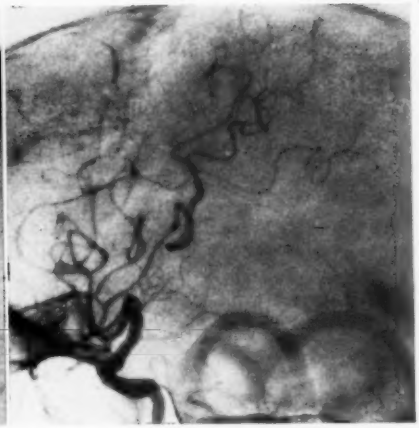

Abb. 7. Mediaverschluss; Ausfall der praefrontalen Äste.

ein etwas ausgedehntes Gebiet der Kandelaberarterie (nach Foix) des Truncus orbito-frontalis (Abb. 5) erhalten.

In einem anderen Fall (Abb. 6) ist lediglich die Arteria temporalis posterior erhalten, während alle anderen Äste ausgefallen sind. Im letzten unserer Fälle (Abb. 7) sind ebenfalls die präfrontalen Äste ausgefallen und die langen Äste der Media erhalten geblieben. Bei dem gleichen Patienten zeigt dann wieder die Analyse der einzelnen Äste auf dem Vorderbild (Abb. 8), wie schwierig es ist, einen tatsächlichen Verschluss zu erkennen. Man wird wohl annehmen müssen, dass bei einer Dreiteilung ein Ast kurz am Abgang verschlossen ist.

Die vorliegende Studie soll dazu beitragen, dass man bei der Diagnostik von Verschlüssen im

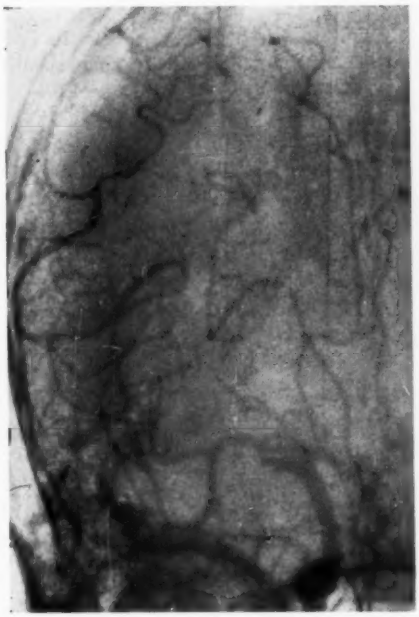

Abb. 8. Mediaverschluss; Vorderbild zu Mediaverschluss bei Ausfall der praefrontalen Äste (Abb. 7).

Mediabereich sich nicht lediglich auf die Routinedarstellung beschränken soll, sondern dass man versuchen muss, die Einzelheiten der Endäste der Media zu analysieren. Dies gilt vor allem, wenn eine klinisch unklares Schlagenfallsbild angiographisch zu untersuchen ist.

ZUSAMMENFASSUNG

Nach einer Studie der normalen Media-Aufzweigungen werden typische Verschlüsse der Media-Äste gezeigt, wobei auf eine subtile Aufnahmetechnik zur genauen Lokalisation hingewiesen wird.

SUMMARY

A study of the normal branches of the middle cerebral artery has shown the presence of characteristic occlusions. This has led to the adoption of an improved roentgenologic technique for their demonstration.

RÉSUMÉ

Une étude des branches normales de l'artère cérébrale moyenne a mise en évidence des obstructions artérielles typiques. Ceci a conduit à adopter une technique radiologique améliorée pour les mettre en évidence.

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THE COLLATERAL CIRCULATION IN THROMBOSIS OF THE INTERNAL CAROTID ARTERY AND ITS BRANCHES

by

M. Rovira, R. Jacas and *A. Ley*

The collateral circulation channels through the brain are abundant, as has been repeatedly shown by numerous investigators, and may prove to be so effective as to compensate for any loss of regular blood supply to an area produced by occlusion of a main arterial trunk.

A complementary circulation in the brain may take place through the following channels: 1) extracranially through the vessels linking both the external and internal carotid arteries, and 2) intracranially through (a) the circle of Willis, (b) the terminal branches of the main cerebral arteries, and (c) the persistence of embryonic vessels connecting the basilar and carotid systems (trigeminal arteries). We have not been able to observe the last mentioned type of compensatory circulation which has been demonstrated angiographically by HARRISON & LUTRELL, by MURTAGH, STAUFFER, & ROBINSON, and POBLETE & ASENJO.

Out of 10 cases of thrombosis of the internal carotid artery or its branches the complementary circulation was established in 7: in 2 cases through the external carotid arteries, in 2 through the circle of Willis, and in 3 cases through the connection of the terminal branches of the cerebral arteries.

Early studies on internal carotid artery thrombosis showed that visual failure on the ipsilateral side due to primary optic atrophy was frequently

seen, so frequently in fact that GUTHRIE, and WALSH & KING thought that it was a constant feature in all cases of internal carotid thrombosis. However, later studies proved that there were cases in which this system was missing, and ELSCHING (cited by SACHS) showed that the preservation of the optic nerve could be attributed to the supply of blood from the external carotid to the ophthalmic artery.

The anatomical findings of ELSCHING were later confirmed by WALSH & KING, who gave a pattern of the vascular connections linking external and internal carotid systems. He admitted the possibility of a retrograde filling of the ophthalmic artery either through the internal maxillary and angular arteries or through some branches of the middle meningeal arteries.

Cerebral angiography played a definite role in clarifying the problem and since its use became generalised there have been numerous instances in which retrograde filling of the ophthalmic and cerebral arteries from the external carotid arteries has been demonstrated. This would account for the preservation of optic and cerebral functions in cases of internal carotid thrombosis, in which the collateral circulation through the circle of Willis proved to be insufficient.

In 1949, MARX published two such cases of supply with filling of the ophthalmic artery through the external carotid arteries. In both cases the linking vessels were the middle meningeal arteries. TORKILDSEN & KOPPANG showed that collateral circulation between the external and internal carotid arteries may take place also through the internal maxillary and superficial temporal arteries, but they emphasized that the most common way was through the middle meningeal artery. SACHS Jr and CHRISTOPHE & THIRY, MACCI & RABAIOTTI, BONNAL & CUCHET and PAILLAS et coll. have published similar findings.

Our observations seem to confirm the foregoing.

Circulation through the circle of Willis. The importance of the circle of Willis as a compensatory device for cerebral circulation is well known and does not need to be stressed. Theoretically its anatomic pattern seems to be ideal for supplying any reduction in the intake of blood coming from each of the main arterial trunks that supply the brain. Unfortunately morphological abnormalities are so frequent (77.2 % after MOREL & WILDE), that what was considered as its normal pattern is rarely found.

The most common abnormalities are those of the communicating arteries which are often reduced to mere fibrous tracts, thus rendering the collateral circulation between the cerebral hemispheres insufficient. Nevertheless its role as an immediate compensatory source of circulation in cases of carotid thrombosis is still of paramount importance, and the favourable evolution which follows in some cases of carotid thrombosis is due, for the most part, to the existence and the appropriate anatomical pattern of the circle of Willis.

a

b

Fig. 1. a) Left carotid arteriogram. Stop (↦) at the beginning of the internal carotid artery. Ophthalmic (†) artery is enlarged. b) The carotid siphon and its branches fill through the ophthalmic artery.

Circulation between the terminal branches of the main cerebral arteries. HEUBNER in 1874 demonstrated the existence of an anastomosis between the leptomeningeal branches of all the cerebral arteries, discarding the assumption held up to that time of the 'terminal' character of the cerebral arteries. Later EECKEN & ADAMS made a very remarkable anatomical study of the brain of adults and new-born children. This proved the existence of such an anastomosis situated especially in the depth of the cerebral sulci. In 1953 EECKEN again studied and demonstrated the same arterial anastomosis in the brain of a still-born human fetus.

In the last few years the study of the anastomosis between cerebral vessels has attracted the interest of clinicians and investigators for the purpose of explaining the mechanisms involved in the restoration of function in cases of thrombosis of the terminal branches of the internal carotid arteries. Thus BIEMOND, and FAY demonstrated the confluence of the cerebral arteries in the surface of the brain. ALEXANDER & PUTNAM, and COBB have shown the same connections microscopically as constituting a superficial remnant of the primitive vascular network where all the cortical arteries are continued without definite limits.

EECKEN & ADAMS pointed out the main ways in which this anastomosis takes place and their work has recently been confirmed by ROSEGAY

Fig. 2.

Fig. 3.

Fig. 2. Thrombosis of the common carotid artery and backflow of the contrast medium into the vertebral artery. Carotid siphon and its branches filled through posterior communicating artery.
Fig. 3. Thrombosis of middle cerebral artery. The posterior branches of the artery filled by collateral circulation from the anterior cerebral artery.

& WELCH, and by GROS et coll. According to these authors the main connections take place mainly at the following points: 1) between the internal frontal branches of the callosomarginal artery (paracentral and precuneal) belonging to the anterior cerebral artery and the precentral, central, and parietal branches of the middle cerebral artery, 2) between the angular branch of the middle cerebral artery and the parieto-occipital branches of the posterior cerebral artery, and 3) between the posterior callosal branches of the anterior cerebral artery and the parieto-occipital branches of the posterior cerebral artery.

All these anastomoses do not seem to have the same functional importance, the most effective being those linking the anterior and middle cerebral arteries and to a lesser degree those which connect the middle and posterior and the anterior and posterior cerebral arteries, respectively (GUIOT & BESNERAIS, ROSEGAY & WELCH, and GROS et coll.). In the areas where the anastomoses are more numerous the compensatory circulation is favoured and the revascularization of the ischemic area therefore more effective. When the thrombosis arises in the middle cerebral artery the situation of the thrombus is of great importance. If it lies at the origin of the artery before the perforating paramedian branches, functional restoration is more possible than if the thrombotic lesion obliterates them. These branches being true terminal arteries do not have connections with other vessels and irrigate vital areas of the brain.

ROSEGAY and WELCH have reported two cases which illustrate very well what we have already said. In their first case the thrombosis obliterated the perforating arteries and the patient had a spastic hemiparesis. In the second in which these arteries were not affected, the patient made a complete recovery.

The first authors who demonstrated this anastomosis angiographically were RANEY et coll. in 1949. In this case the thrombosis of the middle cerebral artery was compensated by an anastomosis connecting this vessel with the anterior cerebral artery. Similar observations were published in 1941 by ETHELBERG, SHURR & WICKBOM and FASANO et coll. In 1954 ROSEGAY & WELCH reported three cases in two of which the anterior cerebral artery was occluded (one by thrombosis and the other by a surgical ligature); in both these cases compensatory circulation through the anterior cerebral artery was demonstrated angiographically. In the third case both anterior cerebral arteries were obliterated and there was a retrograde filling of the calloso-marginal arteries from the anastomotic branches originating in the middle and posterior cerebral arteries. LAFONT et coll. published in 1955 another case of anterior cerebral artery thrombosis in which a collateral circulation from the posterior cerebral artery had developed. GUIOT & BESNERAIS reported a case of surgical obliteration of the middle cerebral artery without neurological consequences in which compensatory circulation was established through the anterior cerebral artery. In 1956 GROS et coll. published four cases, two being of middle cerebral artery thrombosis with revascularisation from the anterior cerebral artery and two of anterior cerebral artery thrombosis with compensatory circulation from the middle and posterior cerebral arteries respectively.

We have observed three cases of circulatory compensation when the thrombosis occurred in the terminal branches of the internal carotid artery. In two of them, the middle cerebral artery was obliterated by thrombosis with compensatory circulation through the anterior cerebral artery, and the third, a thrombosis of the anterior cerebral artery, the collateral circulation was established through the posterior branches of the middle cerebral artery.

Conclusions

It would appear that the development of a collateral circulation in cases of thrombosis of the internal carotid artery and its branches is the rule. How long this compensatory circulation will take to develop we do not know because the angiographic study was performed from two months to ten years after the vascular accident. It also seems to us that the collateral circulation in these circumstances bears no relation to the clinical

progress of the patient, and though the compensatory circulation was quite well developed in most of our cases, only one recovered from the hemiplegia.

Acknowledgment

We should like to take this opportunity of thanking A. CULLA for his cooperation.

SUMMARY

The authors discuss 7 cases of thrombosis of the internal carotid artery or its terminal branches in which the compensatory circulation was demonstrated angiographically. They conclude that this compensatory circulation takes place in almost all cases of thrombosis and the degree of recovery of the patient bears no relation to the subsequent angiographic findings.

ZUSAMMENFASSUNG

Die Verfasser diskutieren 7 Fälle mit einer Thrombose der Arteria carotis interna oder deren Endverzweigungen in denen eine kompensatorische Zirkulation angiographisch beobachtet wurde. Sie ziehen die Schlussfolgerung, dass eine kompensatorische Zirkulation in fast allen Thrombosefällen stattfindet und dass der Grad der Erholung des Patienten zu den späteren angiographischen Befunden in keiner Beziehung steht.

RÉSUMÉ

Les auteurs discutent 7 cas de thrombose de la carotide interne ou de ses branches terminales, où une circulation compensatrice a été visualisée par angiographie. Ils concluent que cette circulation compensatrice apparaît dans presque tous les cas de thrombose et que le degré de récupération du malade est sans rapport avec les résultats de l'angiographie tardive.

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VERTEBRAL ANGIOGRAPHY IN THE DIAGNOSIS OF TUMOURS IN THE PINEAL REGION

by

F. Olov Löfgren

The literature on vertebral angiography includes a few cases of tumours in the pineal region or the adjacent part of thalamus although no survey is available of a relatively large material. The changes described consist mainly of the presence of pathologic vessels and contrast filling of the tumour, with occasional displacement of the posterior choroid artery.

SUGAR, HOLDEN and POWELL (1949) described a metastatic growth from an adenocarcinoma of the thalamus thus: 'arising from the region of the basilar termination is a single vessel passing upward to the region of the thalamus where it breaks up into a circumscribed circular mass of minute blood vessels'. RADNER (1951) reported 3 cases of central tumours which had 'pathologic vessels and diffuse opacification'. TIWISINA (1952) published a case of glioma in the dorsal part of the basal ganglia with 'kapilläre Tumoranfärbung in Walnussgrösse über den horizontal gestreckten A. cerebralis post.' and a case of a tumour in the third ventricle with 'kastaniengrosse kapilläre Tumoranfärbung im Bereich des 3. Ventrikels. Der Tumor wird kelchartig von erweiterten Venen umfasst'.

KRAYENBÜHL and RICHTER (1952) illustrated a case of glioblastoma in the thalamus, in which the posterior choroid artery was pushed occipitally in a wide curve. The termination of the artery on the tumour side was much higher than on the other side. NAMIN (1954) presented a case, stating that the 'tumour occupies the seat of the pineal body and is

partially injected. In addition it deforms the posterior cerebral artery, displacing it downward and stretching it'. COLUMELLA and PAPO (1955) wrote: 'Bei 4 Fällen von Tumoren des Pinealgebietes haben wir dreimal einen kugelförmigen Gefässverlauf nachweisen können, welcher genau die Grösse des Tumors angab.' GLONING and KLAUSBERGER (1955) described a tumour of the thalamus with small pathologic vessels and backward displacement of the posterior choroid artery, which continued abruptly upwards. DECKER (1955) found 'Gefässanfärbung' in 6 out of 18 cases of tumours in the basal ganglia or in the posterior part of the third ventricle. YASARGIL (1957) wrote: 'Die A. Chorioidea posterior wird bei Tumoren des Corpus pineale, des Plexus chorioideus und des Thalamus opticus aufgerichtet.'

The purpose of the present investigation was to assess to what extent it is possible to detect tumours in the pineal region with the aid of vertebral angiography, to obtain a better conception of the types and frequencies of the vascular changes in tumours of the pineal region, and to determine whether the angiographic abnormalities betray the nature and actual site of the tumour.

Material

The material consisted of all cases of tumours in the pineal body and its surroundings examined by vertebral angiography in our department during the years 1947 to 1956.

A tumour in the pineal region is to be understood here as a tumour in the pineal body, quadrigeminal plate, or posterior part of the third ventricle. Tumours in the adjacent part of the thalamus were included because their angiographic appearances may in some respects resemble those of tumours in the pineal region.

The total material consisted of 27 cases, 21 of which had tumours in the pineal region. The patients were between 5 and 54 years, half of them being below 16 years of age. Six patients ranging in age from 28 to 45 had tumours of the thalamus. Of the 27 cases, 18 were histologically verified and of the remaining 9, seven were located with pneumography; the other 2 were not verified. The tumours in the pineal region included 4 pinealomas, 3 teratomas, of which 1 was malignant, 4 astrocytomas, of which 1 was of the intermediate type, 3 glioblastomas, 1 ependymoma, and 1 melanoma metastasis. Among the tumours of the thalamus 1 was an astrocytoma and 1 a glioblastoma. (The histologic material was re-examined by Prof. C. G. AHLSTRÖM, Director of the Pathologic Department).

Vertebral angiography was carried out by the catheterization method of RADNER. The contrast medium used was Umbradil 35 %, 10 ml per

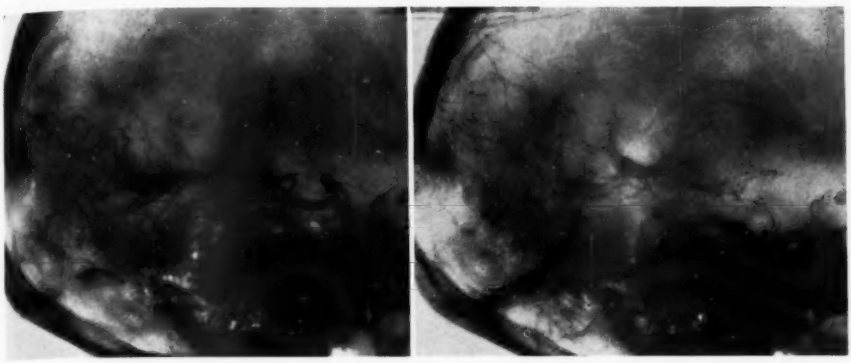
injection, and during the last few years Triurol 25 %, 6 ml per injection. The examinations were made on a Lysholm skull table at a focus—film distance of 75 cm.

The anatomy of the vessels was studied in 100 'normal' vertebral angiograms. This material consisted partly of cases in which encephalography had not shown any pathologic changes and partly of cases in which only vertebral angiography was performed, such as cases with subarachnoidal bleeding and those in which the subsequent clinical course gave no reason to suspect the presence of an expanding process. The patients' ages ranged between 4 and 66, and 15 were under 20 years of age.

Arteries

Anatomy. The arteries of most interest in the diagnosis of tumours in the pineal region are the posterior choroid arteries. Lateral to the cerebral peduncle the posterior cerebral artery gives off two posterior choroid arteries, the medial of which supplies the choroid plexus in the third ventricle and the lateral the choroid plexus in the lateral ventricle. The posterior choroid arteries also give off branches to neighbouring structures (NAMIN 1955). The arteries first run parallel to the posterior cerebral artery and then in the choroid fissure swing round the medial posterior part of the thalamus to proceed upwards in a curve concave forwards. They extend at the same time in a medial direction and run laterally to and over the pineal body up into the tela choroidea of the third ventricle. There, near the midline, they meet the internal cerebral vein which they follow anteriorly in the roof of the third ventricle. The lateral posterior choroid artery passes through the interventricular foramen and supplies the choroid plexus in the upper part of the lateral ventricle.

Angiographic appearance. Only rarely can the posterior choroid arteries be identified in angiograms taken in a frontal projection. In the lateral view two main arteries are usually distinguished: one on either side, each running in a curve convex backwards and upwards from the posterior cerebral artery towards the interventricular foramen. But for deviations of a few millimetres, the pathways of these two main vessels usually coincide. A number of finer vessels are also seen along their course but sometimes the branches are more distinct. The lateral posterior choroid arteries form the largest curves and situated anterior to them are the medial posterior choroid arteries forming more narrow curves (Fig. 1 a). The posterior communicating artery and the anterior portion of the posterior cerebral artery give off some small branches, the thalamoperforating arteries, extending backwards and upwards.



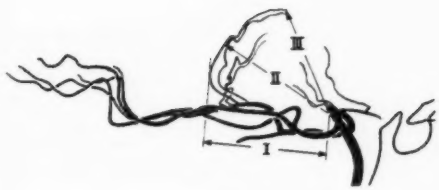
a b

Fig. 1.

a) Normal arteriogram. The lateral posterior choroid arteries form wide curves convex backwards and upwards. Anterior to them the medial posterior choroid arteries form more narrow curves.

b) Normal phlebogram. The internal cerebral veins and great cerebral vein together form an S-curve, convex upwards over the posterior part of the third ventricle and convex downwards below the splenium of the corpus callosum.

c) Drawing from normal arteriogram (a). Three distances are measured from the bifurcation between the basilar artery and posterior cerebral artery to the lateral posterior choroid artery forming the largest curve.

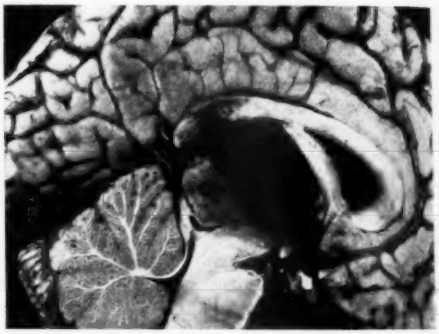


c

The main branch of the posterior choroid artery arises from the posterior cerebral artery 1 to 2 cm posterior to the basilar artery. It usually runs backwards together with the posterior cerebral artery, but sometimes (in about 15 % of cases) it courses 2 to 5 mm above and parallel to the posterior cerebral artery, which it then leaves in an upward curve. In an attempt to determine the ordinary course of this curve, measurements were made in 100 normal vertebral angiograms.

Three distances were measured from the bifurcation between the basilar artery and the posterior cerebral artery (Fig. 1 c): I — the distance to the tangent to the posterior part of the posterior choroid artery as measured along a line parallel to the longitudinal direction of the posterior cerebral artery, II — the greatest distance to the posterior choroid artery, and III — the distance to the anterior upper part of the posterior choroid artery.

a b



c

Fig. 2.

10-year-old boy with large pineal tumour, a teratoma.

a) Curve of the posterior choroid artery much widened and artery displaced backwards and upwards. Dense contrast-filling of tumour.

b) Internal cerebral veins markedly displaced upwards and backwards, forming an acute angle with the great cerebral vein. Large pineal calcifications.

c) Post-mortem findings.

As a rule the posterior choroid artery on either side differed from one another by only a few millimetres. In 3 cases distance I differed by 3 to 6 mm. In 4 cases distance II differed by 4 to 6 mm. In these cases the posterior choroid arteries regularly converged in the upper part of the curve. In 16 cases no filling was obtained of the posterior cerebral artery and the posterior choroid artery on one side.

Since tumours in the pineal region may expand the curve of the posterior choroid artery it is the larger measurements that are of the greatest interest. The measurements of the posterior choroid artery on the side showing the larger curve are given in the diagram below. There is practically no difference between the distances in children and adults.

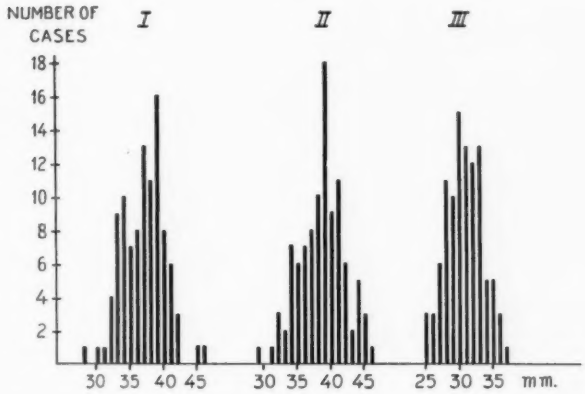


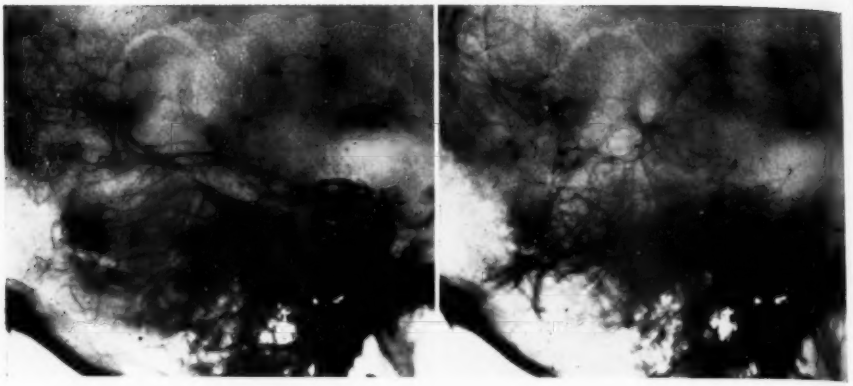
Diagram of measurements of distances, as given in Fig. 1c, in 100 normal vertebral angiograms.

Arterial displacements in the tumour material. Tumours in the pineal region may cause a displacement of the posterior choroid artery, which is then seen in lateral views with a widening of its curve and displacement backwards and upwards (Fig. 2 a). The displacement of the two posterior choroid arteries is symmetric. Only if the tumour is fairly large and situated at the site of the pineal body will it produce any change in the course of the posterior choroid artery. If located in the posterior part of the quadrigeminal plate it will not cause any such displacement because there the posterior choroid arteries diverge laterally downwards. If the tumour is situated in the posterior part of the third ventricle, the curve will not be deformed until the tumour has assumed such dimensions as to lead to expansion of the third ventricle.

Of the 21 cases with a tumour in the pineal region, the curve of the posterior choroid artery was found to be widened in 10. In 3 of these the curve was increased only in height (Fig. 3 a), in the remainder the curve was increased in its entirety.

In 2 cases in which the tumour was situated in the quadrigeminal plate and extended infratentorially the superior cerebellar arteries were found to be markedly depressed. In 8 cases the posterior cerebral arteries were straightened, suggesting the presence of hydrocephalus. In 5 cases the caudal loop of the posterior inferior cerebellar artery was pushed below the foramen magnum indicating herniation of the tonsils.

Tumours in the posterior part of the thalamus may also widen the curve of the posterior choroid artery in the same way as pineal tumours. The displacement is, however, asymmetric and unilateral, the artery on



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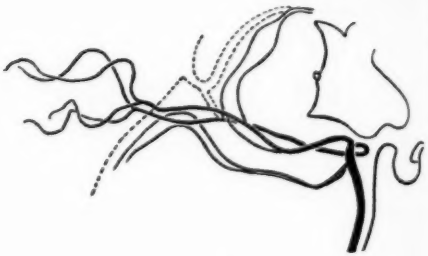


c

Fig. 3.

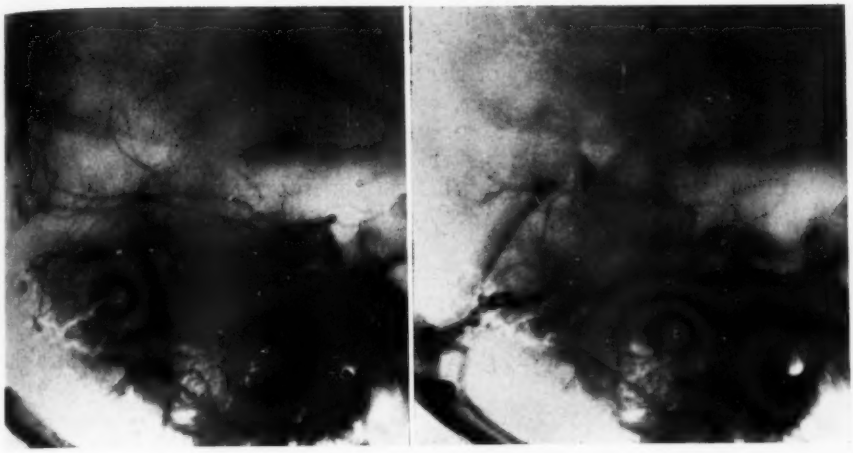
19-year-old man with pineal tumour of moderate size.

a) Curves of posterior choroid arteries increased in height.

b) Internal cerebral veins moderately elevated, and posteriorly with a curve which is convex upwards instead of downwards.

c) Drawing from arteriogram, phlebogram, and pneumogram. Pineal calcification situated in anterior part of tumour with much increased distance to internal cerebral veins.

the other side showing a normal course (Fig. 7 a). In 3 of the 6 cases of tumour of the thalamus, the curve of the posterior choroid artery was markedly widened on one side, while that on the other side had an ordinary appearance. In these 3 cases the tumour was situated in the posterior part of the thalamus and expanded upwards into the cella media of the lateral ventricle and backwards in the trigone. In 3 cases the posterior choroid artery was displaced forwards and downwards on one side, while the artery on the other side presented a normal course (Fig. 8 a). In one of these cases the patient had a cystic tumour lifting the floor of the posterior part of the cella media of the lateral ventricle and compressing the trigone from its medial aspect. Anteriorly the tumour was bordered by the forwardly displaced posterior choroid artery. In the other 2 cases the tumour was limited to the thalamus with compression of the third ventricle, and the floor of the cella media of the lateral ventricle was slightly raised.



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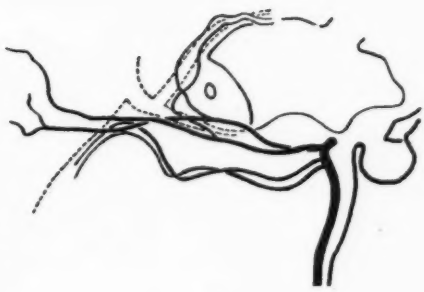


c

Fig. 4.

10-year-old boy with a small pineal tumour, a pinealoma.

a) No arterial displacement.

b) Posterior part of internal cerebral veins straightened, and forms an angle instead of a normal S-curve with the great cerebral vein.

c) Drawing from arteriogram, phlebogram, and pneumogram. Anterior border of tumour defined by outline of third ventricle, and posterior border by internal cerebral veins. Distance between pineal calcification and internal cerebral veins slightly increased.

Moreover, the lateral localization of the tumour was in one case recognized in the frontal view by the medial displacement of the posterior cerebral artery and in two cases by the displacement of the superior cerebellar artery towards the other side. In one case there were pathologic vessels which could be seen in the frontal view as well.

Veins

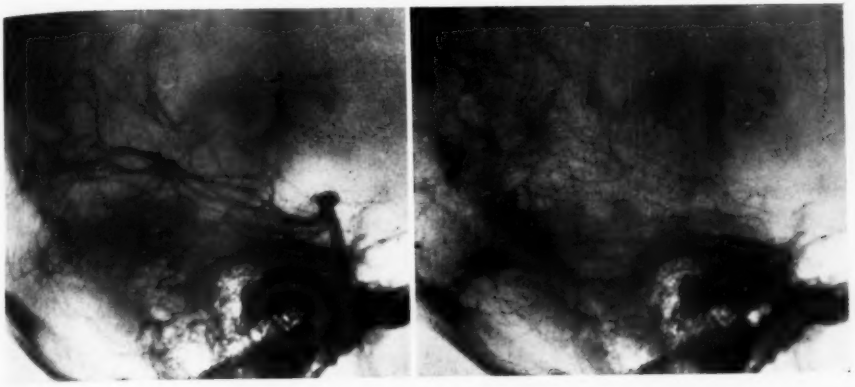
Anatomy. The veins of particular interest in the diagnosis of tumours in the pineal region are the internal cerebral veins, the basilar veins, and the great cerebral vein. The internal cerebral vein runs from the interventricular foramen backwards in the tela choroidea of the third

ventricle, close to the medial upper surface of the thalamus. It passes immediately above the pineal body and below the splenium of the corpus callosum. The anterior part of the vein forms a curve, convex upwards, and the posterior part a curve, convex downwards. The anterior part of the vein lies close to the midline and to the internal cerebral vein on the other side. In their posterior part the veins are separated by a few millimetres before they join behind the inferior part of the splenium to form the unpaired great cerebral vein. The basal vein runs in the ambient cistern together with the posterior cerebral artery lateral to the cerebral peduncle. It then continues upwards in a medial direction and passes half a centimetre lateral to the quadrigeminal plate above which, from either side, it enters the great cerebral vein. Together with the inferior sagittal sinus the great cerebral vein empties into the straight sinus (JOHANSSON 1954).

Angiographic appearances. In vertebral angiograms the internal cerebral veins and the basal veins do not appear in their entire length as in carotid angiography, since they receive the major portion of their supply from the internal carotid artery. No filling is obtained of their anterior part. In the middle portion a filling of low density is discernible, a filling which increases in density posteriorly towards the great cerebral vein. The veins on both sides are contrast-filled simultaneously. In lateral views the internal cerebral vein and the basal vein of one side are superimposed upon those of the other. A few small contrast-filled veins from the thalamus are often seen immediately below the internal cerebral veins. They are situated just below the middle of the internal cerebral veins, towards which they converge; they empty into these veins posteriorly. Contrast-filling only of these veins is sometimes observed. The internal cerebral veins and the great cerebral vein together form an S-curve, convex upwards, over the posterior part of the third ventricle and convex downwards below the splenium of the corpus callosum (Fig. 1 b). The great cerebral vein usually enters the straight sinus more or less perpendicularly.

It is usually not possible to identify the internal cerebral vein and the basal vein in frontal views at vertebral angiography. No filling is obtained of their lateral supplies, *e.g.* the striothalamic vein, and their medial parts are superimposed by the straight sinus and numerous veins from the cerebellum.

Displacement of the veins in the tumour material. Tumours in the region of the pineal body may displace the internal cerebral veins upwards and backwards. An angle develops between the internal cerebral veins and the great cerebral vein in place of the normally S-shaped



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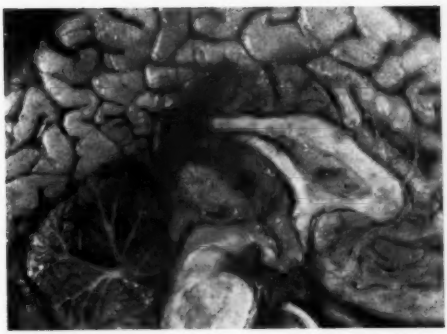


c

Fig. 5.

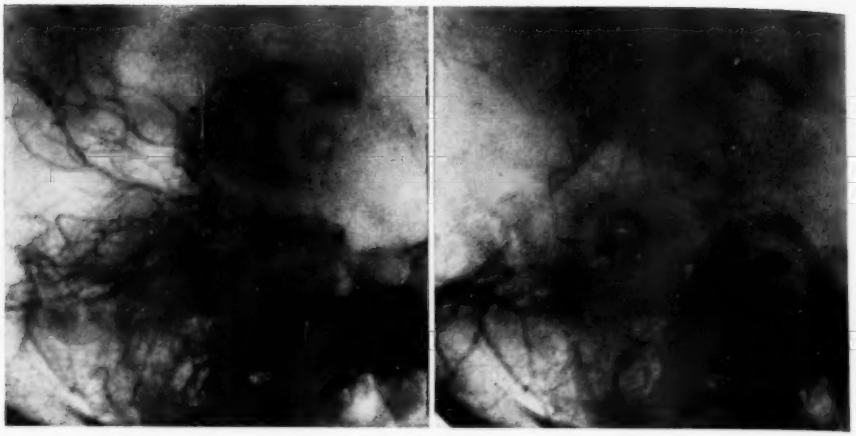
32-year-old woman with pineal tumour, a glioblastoma.

a) and b) Arteriogram and phlebogram show abundant fine pathologic vessels.

c) Post-mortem findings.

curve (Fig. 2 b). The venous displacement appears earlier than displacement of the posterior choroid artery by tumours in the pineal region because the internal cerebral veins are situated above and behind the pineal body, while the posterior choroid arteries are situated laterally to the pineal body and diverge downwards. No such displacement occurs if the tumours are small and situated mainly in the posterior part of the third ventricle or in the lower inferior part of the quadrigeminal plate.

In 12 of the 21 cases of tumour in the pineal region the internal cerebral veins were displaced upwards. When the displacement was slight, the posterior part of the internal cerebral veins was straightened and formed an angle with the great cerebral vein in place of the normal S-shaped curve (Fig. 4 b). When the displacement was moderate, the posterior part of the internal cerebral veins was slightly elevated with



a b

Fig. 6. 5-year-old boy with pineal tumour, a teratoma.
a) Arteriogram. Several coarse pathologic vessels.
b) Phlebogram. Moderate contrast-filling of tumour.

a curve convex upwards instead of downwards (Fig. 3 b). When the displacement was marked the entire internal cerebral veins were considerably raised in a curve, convex upwards and backwards, in addition to which they were displaced backwards together with the great cerebral vein with which they formed an acute angle (Fig. 2 b). In these advanced cases the angle between the great cerebral vein and the straight sinus was also acute. Of those cases in which there was no displacement of the posterior choroid artery, two showed a straightening of the posterior portion of the internal cerebral veins with the formation of an angle with the great cerebral vein (Fig. 4).

In one case with a tumour of the quadrigeminal plate extending infratentorially, the downwards convex curve of the internal cerebral veins and the great cerebral vein was lifted and straightened and the basal vein was also displaced upwards.

While tumours in the pineal region often displace the internal cerebral veins upwards and backwards more markedly than the posterior choroid artery, tumours of the thalamus produce the opposite change in the vascular pattern. The curve of the posterior choroid artery may be considerably widened without the internal cerebral veins being lifted at all. They may be straightened or displaced downwards and forwards with flattening of the upwards convex curve.

In the 3 cases of thalamus tumour in which the curve of the posterior

choroid artery on one side was markedly increased the internal cerebral veins were slightly straightened and their position was almost normal, like that of the contralateral posterior choroid artery (Fig. 7 b). In the 3 cases in which the posterior choroid artery on one side was displaced forwards and downwards the internal cerebral veins were straightened and displaced downwards, and together with the great cerebral vein formed a wide flat curve convex downwards (Fig. 8 b).

Pathologic vessels

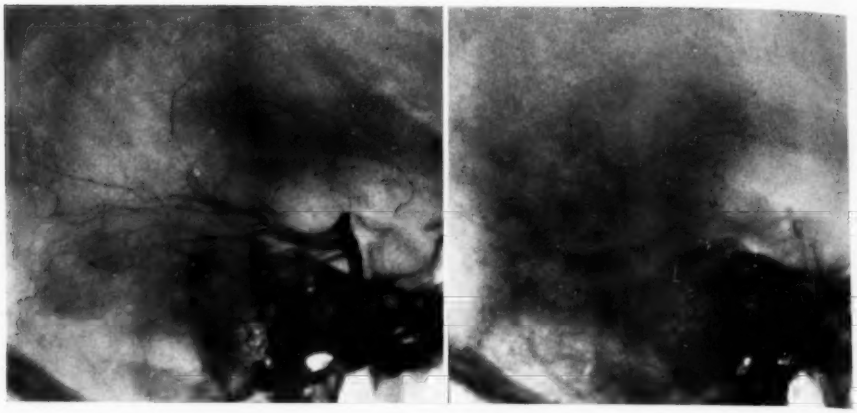
Of the 21 tumours in the pineal region, pathologic vessels and/or contrast-filling of tumour were seen in 9. Of these cases, 3 received radiotherapy only, while 6 were operated on. The histologic findings were teratoma in 3 cases and glioblastoma in the other 3. The ages of the patients with teratoma were 5, 10 and 13, with glioblastoma 32, 35 and 36 years.

No distinct difference was discernible in the vascular patterns between these two groups. Most cases displayed a varying amount of fine vessels and a slight or no contrast-filling of the tumour (Fig. 5) and in one case several coarse pathologic vessels and a moderate flush were seen (Fig. 6). In one case the tumour was extremely well filled, but no pathologic vessels were evident (Fig. 2).

Judging by this small material, it appears that tumours situated in the pineal region with pathologic vessels, or which become contrast-filled, are probably teratomas in children and glioblastomas if present in adults.

Pineal calcification

Pineal calcification is strikingly common in the presence of tumours in the pineal region. Camp (1950) wrote: 'Roentgenologic evidence of pineal calcification is rare under ten years of age and when present should suggest a pinealoma.' Rand and Lemmen (1953) reported a clinical material of 32 cases with tumours in the posterior part of the third ventricle. In 7 patients, 5 of whom were 15 years or younger, the tumour was suspected because of solid calcification of the pineal body. The demonstration of calcifications in the pineal body is of the greatest significance in children who normally seldom have such changes. Naffziger (1925) in examinations of skull roentgenograms noted calcifications in 15.5 % of 45 subjects below the age of 20. Vastine & Kinney (1927) found no calcifications in 9 children under 10 years of age and calcifications in 18.5 % of 74 subjects aged between 10 and 20 years, or a percentage of 16.5 in 83 subjects below 20 years of age. Lilja (1939) reported no calcifications in 30 children under 10 years of age and calcifications in 18.9 % of 106 subjects aged between 10 and 20, or a percentage of 14.7 in 136 subjects below 20 years of age.



a b

Fig. 7. 38-year-old man with tumour of thalamus, a glioblastoma.
a) Curve of posterior choroid artery markedly widened on tumour side. Artery on the other side normal.
b) Straightened internal cerebral veins. A few fine pathologic vessels around middle part of internal cerebral veins.

In the present material of normal vertebral angiograms 16 subjects were below 20 years of age. Only one had calcifications in the pineal body. Of the 21 patients with a tumour in the pineal region, 13 were under 20, the youngest being 5 years old. The size of the pineal calcification as measured in lateral films varied between 1 × 1 and 7 × 7 mm, and the histologic findings were teratoma in 3 cases, pinealoma in 4, and astrocytoma in 2 cases. Four cases were not examined microscopically. Of the 13 patients under 20 years of age with a tumour in the pineal region, calcifications were present in 9 (69 %). In the normal materials of NAFFZIGER, of VASTINE & KINNEY, and of LILJA, the frequency of calcifications in subjects under 20 was 15.5 %, 16.5 %, and 14.7 %, respectively. A pineal calcification in children thus strongly suggests the presence of a tumour in the pineal region, especially if the calcification is large. All the cases with verified pinealoma and teratoma had calcifications whereas two cases with astrocytoma had none. The presence of a calcification therefore suggests the presence of a pinealoma or teratoma.

Topographic relationship between a pineal calcification and the internal cerebral vein. In his monograph on the central veins as seen in carotid angiograms JOHANSSON (1954) wrote: 'When pineal calcifications are visible, expanding processes in the region of the pineal body are seen to result in an increase in the distance between them and the internal

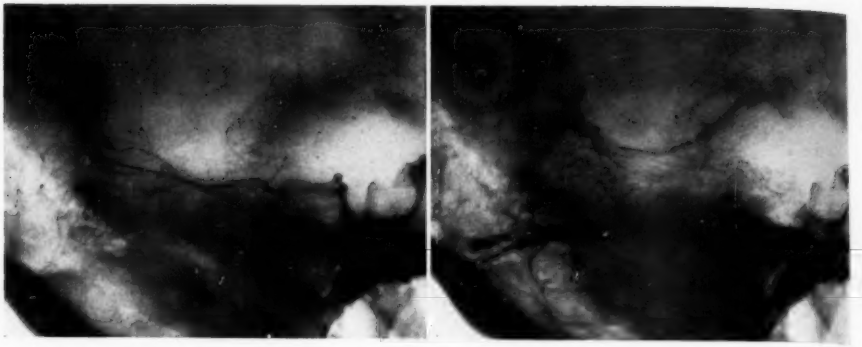
cerebral vein. In ordinary cases this distance is at most a few millimetres since the internal cerebral vein lies close to the superior surface of the pineal body, slightly lateral to the midline.'

In the present material of 100 normal vertebral angiograms calcification was found in 43. The distance between the outline of the calcification and the internal cerebral vein was 0 to 3 mm. In 3 cases, however, the distance was as great as 4 to 6 mm. In the case in which the greatest distance (6 mm) was measured, the pneumogram showed an unusually large pineal recess between the internal cerebral veins and the pineal calcification. The distance between the outline of the calcification and the confluence of the internal cerebral veins and the basal veins was also measured and found to vary between 0 to 10 mm.

Of the 21 patients with tumours in the pineal region calcification was demonstrated in 13. In most of them the distance to the internal cerebral veins and to the confluence lay within a normal range. Displacement of the pineal calcification was suspected in 8 cases; in 3 the distance to the internal cerebral vein was 4 mm and in 2 cases the pineal calcification was situated slightly behind the confluence of the internal cerebral veins and the basal veins. In the remaining 3 cases the distances were markedly increased; in 2 of these, in which the calcification was seen in the middle of the tumour, the distance to the internal cerebral veins was 12 mm and to the confluence 17 mm and 20 mm, respectively. In the third case, in which the calcification was situated in the periphery of the tumour the corresponding distances were 20 mm and 27 mm (Fig. 3c).

Conclusions

Tumours in the pineal region, if large enough, may be diagnosed by means of vertebral angiography. The changes in the vascular pattern are best seen in the lateral view. Such tumours displace arteries as well as veins; both posterior choroid arteries are pushed upwards and backwards, the curve of the posterior choroid artery is increased and the internal cerebral veins are displaced upwards and backwards. If the displacement is slight, the posterior part of the internal cerebral veins is straightened so that an angle develops between the internal cerebral veins and the great cerebral vein in place of the normal S-shaped curve. If the displacement is more marked, the internal cerebral veins are lifted in a curve convex upwards and backwards and the angle between the internal cerebral veins and the great cerebral vein then becomes acute. The displacement of the veins appears earlier than that of the arteries and a straightening of the internal cerebral veins may sometimes be demonstrated without any arterial displacement.



a b

Fig. 8. 28-year-old woman with thalamus tumour, an astrocytoma.

a) Posterior choroid artery displaced slightly forwards and downwards on one side; artery on the other side normal.

b) Internal cerebral veins together with the great cerebral vein form a wide flat curve convex downwards.

Tumours in the posterior part of the thalamus may produce displacement of the posterior choroid artery, similar to that seen in pineal tumours; thalamic tumours, however, displace this artery only on the side involved by the tumour, the pattern on the other side being normal. Pineal tumours push the internal cerebral veins upwards in the same way as the arteries; tumours of the thalamus on the other hand displace these veins in a curve convex downwards or sometimes only straighten them. Both pineal tumours and thalamic tumours sometimes have pathologic vessels and show tumour staining. The frontal view will then reveal the site of the tumour.

In order to ascertain how large a tumour must be to produce any demonstrable vascular displacement, the pineal tumours were arranged according to size. A lateral arteriogram, phlebogram, and pneumogram of each case were traced on the same drawing and the length and width of the tumour was measured (Fig. 3c, 4c). The anterior border of the tumour is seen in the pneumogram where the tumour bulges into the third ventricle; the upper and posterior outlines are marked by the internal cerebral veins and the posterior choroid arteries, the lower border by the beginning of the cerebral aqueduct. In a few cases it was possible to recognize the border of the tumour in the encephalogram by the cisternal gas surrounding it. In some cases the tumour was contrast-filled and then appeared as a well outlined mass.

The length and height of the tumours have been measured on drawings according to Figs. 3c and 4c. It was found that tumours measuring 2.5 × 3 cm or more produced a demonstrable displacement of the posterior choroid arteries as well as of the internal cerebral veins. An exception was a tumour (3.5 × 2.5 cm) of the quadrigeminal plate which bulged only slightly into the third ventricle and was situated mainly infratentorially. This was indicated by a marked depression of the superior cerebellar arteries. A similar angiographic appearance was seen in another case but the tumour was so large (4 × 4 cm) that it also displaced the vessels above the tentorium.

Tumours measuring 2.5 × 2.5 cm or less produced no displacement of the posterior choroid artery but two caused a slight displacement of the internal cerebral veins; in these 2 cases, in which the tumour measured 2.5 × 2.5 cm and 1.5 × 1.5 cm, the masses were situated at the site of the pineal body and bulged only moderately into the third ventricle.

Eight tumours measuring 2.5 × 2 cm or less did not displace the posterior choroid arteries or the internal cerebral veins; 6 were situated mainly in the posterior part of the third ventricle. In 1 case the tumour lay at the site of the pineal body but was not large enough (1 × 1 cm) to displace the internal cerebral veins; in another there was a small tumour (1 × 1 cm) in the quadrigeminal plate.

If the tumour has pathologic vessels and/or becomes contrast-filled it may in children be a teratoma or in adults a glioblastoma. Calcification of the pineal body in children strongly suggests a tumour in the pineal region, especially if the calcification is extensive. The distance between the pineal calcification and the internal cerebral veins may be increased; if the distance exceeds 3 mm, a tumour should be suspected; if the distance is over 6 mm it may be diagnosed with confidence.

In the present investigation 13 of the 21 tumours in the pineal region could be diagnosed by vertebral angiography, a method which is a valuable one for examining the pineal region and adjacent part of the thalamus. In some cases contrast-filling of pathologic vessels and of tumour betray the exact site and size of the tumour; in others the procedure forms an excellent supplement to pneumography. Vertebral angiography and pneumography together permit a precise determination of the essential features of the tumour.

SUMMARY

A description is given of the appearances of the pineal region based on a material of 100 normal angiographies. An analysis is presented of 21 cases of tumour in the pineal region and 6 cases of tumours in the adjacent part of the thalamus. The changes are described and discussed.

ZUSAMMENFASSUNG

Auf Grund von 100 normalen Angiographien wird das Aussehen der Pinealgegend beschrieben. Eine Analyse von 21 Tumorfällen im Gebiete des Corpus pineale und von 6 Tumoren im angrenzenden Abschnitt des Thalamus wird vorgelegt. Die Veränderungen werden beschrieben und besprochen.

RÉSUMÉ

Description des aspects de la région pinéale d'après une série de 100 angiographies normales. L'auteur présente une analyse de 21 cas de tumeur de la région pinéale et de 6 cas de tumeur de la partie voisine du thalamus. Il décrit et étudie les modifications radiologiques.

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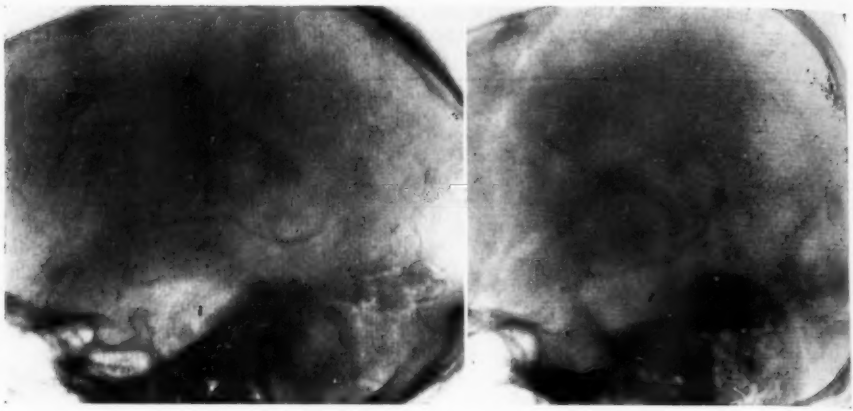
LE SIGNE DE L'OPACIFICATION VEINEUSE LOCO-RÉGIONALE PRÉCOCE AU COURS DE LA SÉRIO-ANGIOGRAPHIE RAPIDE CAROTIDIENNE

par

E. Woringer, J. Baumgartner et *J. P. Braun*

L'opacification précoce d'une veine (OVP) du cerveau située au voisinage d'une lésion vasculaire ou tumorale, dans l'angiogramme par voie carotidienne, est un phénomène connu, mais dont la valeur n'a peut-être pas été suffisamment soulignée. Il est beaucoup moins connu quand il apparaît au cours d'autres lésions cérébrales. Le présent travail est consacré à définir le signe de l'opacification précoce de certaines veines du phlébogramme, à en peser la valeur séméiologique et à circonscrire les limites de sa signification pathologique.

Les angiographies qui ont servi à l'exécution de ce travail ont été pratiquées selon une technique standard. Elle consiste, à l'aide du sério-angiographe AOT de Schönander, à faire défiler les clichés à une cadence de un par seconde de la première à la septième seconde et de un toutes les deux secondes de la septième à la treizième seconde après injection en une ou deux secondes de 8 ml de produit de contraste (Diodone à 35 %). Cette technique appliquée à 537 sérioangiographies nous donne l'assurance de saisir l'apparition du phlébogramme à une seconde près et, pratiquée par routine en si grand nombre, nous donne la garantie de résultats com-



a b

Fig. 1. Opacification précoce: a) de la veine cérébrale interne dans un gliome capsulaire et thalamique, b) des veines cérébrales interne et basilaire, dans un hématome intra-parenchymateux.

parables. Les sujets sur lesquels elle a été mise en oeuvre ont pu être considérés pour certains d'entre eux comme normaux au moment de l'épreuve; mais pour la plus grande part il s'agissait de sujets atteints d'affections cérébrales les plus diverses.

Définition. Nous avons admis la présence du signe de l'opacification veineuse précoce (OVP) chaque fois qu'une des conditions suivantes était réalisée.

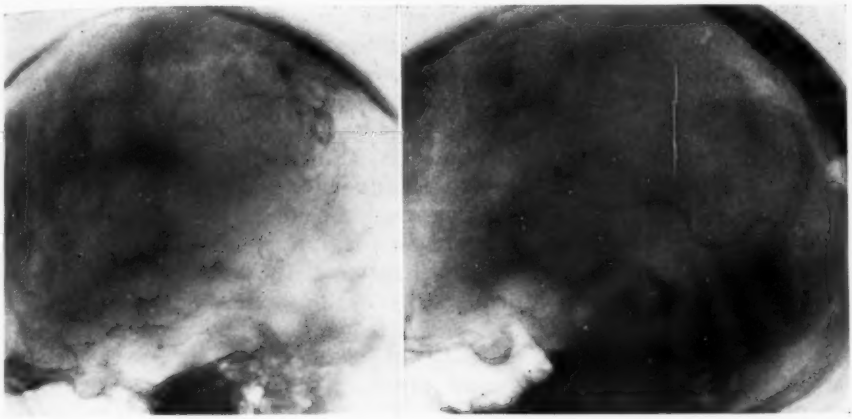
1. Apparition d'une ou de plusieurs veines pathologiques groupées avant l'opacification du phlébogramme normal.

2. Apparition d'une opacification précoce d'une ou de plusieurs veines normales d'un même système veineux à l'exclusion de l'autre (profond ou cortical).

Une veine qui s'opacifie simultanément avec d'autres, mais qui s'en différencie du fait d'une densité d'opacification accrue, ne peut pas être considérée comme une injection veineuse précoce. Ainsi défini, le signe de l'OVP n'a de valeur que dans le cadre de la technique angiographique telle que nous l'avons décrite.

Résultats

Cas normaux. Le signe de l'OVP n'a jamais été trouvé dans nos 22 sérioangiographies pratiquées chez des sujets normaux. Dans ces cas il y a toujours eu, sans systématisation topographique, une opacification simul-



a b

Fig. 2. Opacification précoce: a) des veines pariéto-occipitales ascendantes dans une métastase cérébrale d'un néoplasme du sein, b) de la veine anastomotique de Labbé dans une métastase temporale gauche d'un épithéliome bronchique.

tanée d'une ou de plusieurs veines des deux systèmes phlébographiques, profond (veine striothalamique, veine du septum lucidum, veine cérébrale interne, grande veine de Galien et veine basilaire de Rosenthal) et cortical (veines ascendantes, veines anastomotiques de Trolard et de Labbé, veines de la vallée Sylvienne). (Nous n'insisterons pas ici sur l'aspect de l'injection simultanée qui mérite à elle seule une large discussion, nous signalons simplement les faits tels que nous les avons mis en évidence avec notre technique standard.)

Tumeurs. Nos tumeurs ont été réunies en groupes selon leur variété histologique, et pour chacun d'eux la fréquence du signe de l'OVP a été recherché.

Dans le groupe des *glioblastomes* 31 sérioangiographies ont été pratiquées et 26 fois le signe de l'OVP a été présent. Vu la fréquence de la possibilité de l'OVP parmi ces tumeurs, il fallait se demander quelle pouvait être la cause de sa négativité pour 5 d'entre elles. Ayant remarqué sa relative rareté en cas de meningiome, où il y a même retard d'injection veineuse au pourtour de la tumeur, on pouvait supposer que l'explication de l'absence de l'OVP était donnée par l'expansion non infiltrante, repoussant devant elle un réseau veineux mis à l'étroit et de ce fait à circulation réduite. Or parmi les 5 gliomes en question, 3 comportaient précisément de grands kystes et s'apparentaient par celà avec le mode d'expansion du méningiome.

Dans nos 4 cas de *neurospongiomes* ce signe a été présent quatre fois. Chez un de ces malades opéré et traité à diverses reprises par radiothérapie pour récidive, le signe de l'OVP n'a pas été retrouvé sur les cinq nouvelles sérioangiographies pratiquées au cours des trois années qui ont suivi l'intervention.

Sur deux cas d'*oligodendrogliomes*, dont l'un du septum lucidum et ayant comporté un examen angiographique bilatéral, ce signe a été trouvé trois fois. Chez l'un des deux il n'a plus été mis en évidence après l'intervention.

Chez cinq malades atteints d'*astrocytomes*, six sérioangiographies ont été pratiquées, dont l'une après récidive. Six fois il existait une injection veineuse précoce.

Par ailleurs sur les 38 sérioangiographies pratiquées en cas de *méningiomes*, ce signe a été présent dix fois: sept fois sur 21 sérioangiographies pour métastases et quatre fois pour 17 sérioangiographies pratiquées pour des tumeurs diverses et indéterminées.

Il est important de noter les faits suivants à propos du signe de l'OVP en cas de tumeur.

1. Ce signe a existé dans la presque totalité de nos tumeurs malignes, glioblastomes, neurospongiomes, oligodendrogliomes et astrocytomes. Il constitue par conséquent à lui seul une forte présomption en faveur de cette sorte de tumeur.

2. Le signe de l'OVP, en cas de drainage direct d'une tumeur par une veine peut parfois être si grossier qu'il apparaît déjà en plein dans la phase artérielle de l'angiogramme où il peut se manifester même en cas de nombre réduit de clichés. Le plus fréquemment cependant il est discret et ne peut être mis en évidence que par la sérioangiographie à cadence rapide.

3. Cette OVP a toujours été observée dans la région occupée par la tumeur.

4. Ce signe peut exister en l'absence de toute opacification tumorale et de toute déformation morphologique du réseau vasculaire cérébral. Dans ces cas en particulier l'injection veineuse précoce constitue un appoint sérieux au diagnostic étiologique et topographique.

Malformations vasculaires. Le signe de l'opacification précoce a été régulièrement présent dans nos huit cas d'*angiomes artério-veineux* sériographiés. Cette fréquence de 100 % est logique, puisque le signe de l'OVP est le résultat des shunts artério-veineux qui caractérisent ces lésions. Il n'a par contre jamais été mis en évidence sur les dix sérioangiographies pratiquées pour *anévrismes artériels.*

Autres affections cérébrales. Nous avons groupé dans un même chapitre tout le restant de la pathologie cérébrale ayant nécessité des examens

sérioangiographiques. Il s'agit de traumatismes craniens avec ou sans hématomes (extra- ou sous-dure-mérien ou intraparenchymateux), de crises nerveuses, d'atrophies cérébrales, de troubles vasculaires aigus, chroniques ou spasmiques, de thromboses, d'hémorragies méningées, d'encéphalites et de certaines autres affections cérébrales diverses. Dans ces cas le signe de l'OVP a été retrouvé 57 fois sur un nombre total de 371 sérioangiographies. Sa recherche dans des cas de pathologie tellement variée et disparate pourrait sembler stérile et sa présence aurait pu être le fait de raisons fortuites. Mais il n'en a rien été et en regard de sa rareté il faut souligner le fait que son existence était presque toujours liée, d'une façon très précise, à une lésion parenchymateuse localisée. Six fois seulement sur ces 57 injections précoces les investigations cliniques et autres ne nous ont pas permis de lui trouver une corrélation avec l'affection incriminée.

L'étude de ce groupe suggère deux remarques.

A. Dans nos cas de lésions circulatoires, classées en aiguës et chroniques, suivant le moment où s'est placée l'angiographie par rapport à l'apparition du trouble vasculaire, nous avons pu faire la constatation que sur les 21 sérioangiographies faites chez des malades atteints de troubles circulatoires aigus le signe de l'opacification veineuse précoce n'a été présent que deux fois, tandis qu'il a pu être décelé sept fois sur les 41 angiographies pratiquées chez les malades à troubles vasculaires plus anciens. Peut-être y aurait-il corrélation entre l'organisation anatomique consécutive à ces troubles vasculaires et l'injection précoce.

Deux exemples nous permettent peut-être de répondre par l'affirmative à cette question:

1. Il s'agit d'un homme de 50 ans, admis à la suite d'un traumatisme cranien et chez lequel une angiographie, pratiquée en vue d'éliminer un hématome, a montré une intégrité morphologique du réseau vasculaire cérébral. Une nouvelle angiographie pratiquée 15 jours plus tard à cause de son aggravation clinique montra, en plus d'une déformation parlant en faveur d'un processus frontal basal postérieur, une opacification veineuse précoce de la veine basilaire de Rosenthal qui n'avait pas existé lors de l'examen précédent. L'intervention confirma l'existence d'une poche assez importante de tissu cérébral ramolli. L'apparition de l'opacification veineuse précoce est probablement le fait d'un remaniement tissulaire et vasculaire au cours de ce processus cérébral pathologique.

2. Il s'agit de deux cas d'hémiparkinson, les seuls dont nous possédions une angiographie et chez lesquels il existait une opacification veineuse précoce du système profond. L'OVP est ici la manifestation angiographique d'une lésion parenchymateuse circonscrite et d'installation ancienne et comportant des modifications vasculaires.

B. Nous relaterons encore ici la très intéressante observation concernant une jeune femme chez qui une suspicion d'embolie septique nous avait incités à pratiquer une artériographie. Celle-ci, malgré la symptomatologie clinique massive (hémiplégie + aphasie) démontrait une intégrité morphologique du système vasculaire cérébral; cependant il apparaissait une injection veineuse précoce de la région dans laquelle s'est développé dans les trois semaines suivantes un abcès cérébral (vérifié artériographiquement et opératoirement). Ce signe de l'OVP s'explique peut-être par l'hyperémie locale accompagnant le stade inflammatoire et précédant la formation de l'abcès.

Commentaires

Le signe de l'opacification veineuse précoce peut à la lumière du contexte clinique et anatomo-pathologique de 125 cas où il a été observé, trouver son explication pour le moins dans trois mécanismes d'ordre vasculaire et qui sont:

Les *shunts artério-veineux* comme c'est le cas pour l'angiome artério-veineux et à un degré moindre pour les tumeurs malignes.

Les *néoformations vasculaires* au voisinage de lésions parenchymateuses dégénératives en voie d'organisation.

L'hyperémie localisée au cours d'états inflammatoires cérébraux circonscrits.

Conclusion

Le signe de l'opacification veineuse précoce a été décrit et défini à propos de l'analyse de 537 sérioangiographies cérébrales normales et pathologiques, pratiquées selon une technique routinière de 10 clichés par examen. Il n'a jamais été mis en évidence dans les 22 cas de sérioangiographies normales. La fréquence de sa présence en cas de tumeur cérébrale maligne a été soulignée et considérée comme un appoint supplémentaire au diagnostic angiographique de cette sorte de tumeur. En présence de malformations vasculaires ce signe est obligatoire dans les cas d'anévrysme artério-veineux et absent dans les cas d'anévrysme artériel. Dans un large groupe comportant des cas de lésions cérébrales diverses, tels les traumatismes craniens avec ou sans hématome, les crises nerveuses, les atrophies cérébrales, les troubles vasculaires, les thromboses artérielles, les états infectieux cérébraux et des affections cérébrales autres, ce signe de l'opacification veineuse précoce a été mis en évidence dans 15 % des cas (57 fois pour 371 sérioangiographies).

Sa relative rareté dans tout le reste de la pathologie cérébrale a été compensée par une grande fidélité puisqu'il témoignait presque toujours

d'une lésion anatomique dans son voisinage immédiat, qu'elle soit d'ordre vasculaire, tumoral, dégénératif ou infectieux. En ce sens l'OVP est un signe dont la valeur séméiologique mérite d'être retenue.

A de rares exceptions près ce signe a pu être mis en relation avec une atteinte cérébrale circonscrite se manifestant par une symptomatologie clinique, électroencéphalographique, pneumencéphalographique ou anatomique.

Le mécanisme de son apparition a été attribué à une origine vasculaire anatomique ou fonctionnelle (shunts artério-veineux, néoformations vasculaires accompagnant les lésions parenchymateuses en voie d'organisation ou hyperhémie accompagnant les états inflammatoires circonscrits).

RÉSUMÉ

L'opacification veineuse précoce est décrite et définie à propos de l'analyse de 537 sérioangiographies cérébrales normales et pathologiques, pratiquées selon une technique routinière de 10 clichés par examen. L'OVP n'a pas été mise en évidence dans les 22 cas de sérioangiographies normales. La fréquence de sa présence en cas de tumeur cérébrale maligne est soulignée et considerée comme un appoint supplémentaire au diagnostic angiographique de cette sorte de tumeur.

SUMMARY

Early venous contrast-filling is described and defined on the basis of an analysis of 537 normal and abnormal serial cerebral angiographies, performed with a routine technique of 10 exposures for each examination. Early contrast-filling of the veins could not be demonstrated in any of the 22 cases examined with normal serial angiography. Its frequent demonstration in cases of malignant brain tumours is pointed out and considered as an additional aid to the angiographic diagnosis of such tumours.

ZUSAMMENFASSUNG

Frühzeitige venöse Kontrastfüllung, auf Grund einer Analyse von 537 normalen und pathologischen cerebralen Reihenangiographien, die mit einer rutinmässigen Technik von 10 Exponierungen für jede Untersuchung ausgeführt wurden, wird beschrieben und beurteilt. Solche Kontrastfüllung wurde in keinem der 22 Fälle mit normaler Reihenangiographie erhoben. Das häufige Auftreten in Fällen mit malignen Hirntumoren wird hervorgehoben und als zusätzliches Hilfsmittel für die Stellung der angiographischen Diagnose derartiger Tumoren betrachtet.

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CAROTID ANGIOGRAPHY IN EIGHT CASES OF UNILATERAL OPHTHALMOPLEGIA

by

Giovanni Di Chiro

During the last two years 8 cases of unilateral ophthalmoplegia have been investigated by means of arteriography. Five of these cases had clinical signs of a "cavernous sinus syndrome", the third (III), fourth (IV), and sixth (VI) cranial nerves being affected while the fifth (V) cranial nerve was more or less impaired by the posterior or anterior extension of the lesion causing the ophthalmoplegia. In 2 cases impairment of III was present, being, in one instance, combined with marked diminution of vision of the affected eye. In another case exophthalmos and paresis of VI dominated the clinical picture. It should be noted that 5 cases of the present series presented exophthalmos of a varying degree on the ophthalmoplegic side.

Conventional films of the skull including special views of the optic canals and spheno-sphenoidal fissures were obtained in all the cases and carotid angiography was carried out on the side of the ophthalmoplegia in every instance. In 4 cases, however, angiography was also performed on the opposite side. In 2 cases in which these examinations had failed to show any abnormality, they were supplemented by encephalography in order to rule out the presence of an intracranial space-occupying lesion.

In 2 cases the roentgenologic findings were all within normal limits. In one the presence of an intracranial tumour, partly extending through the

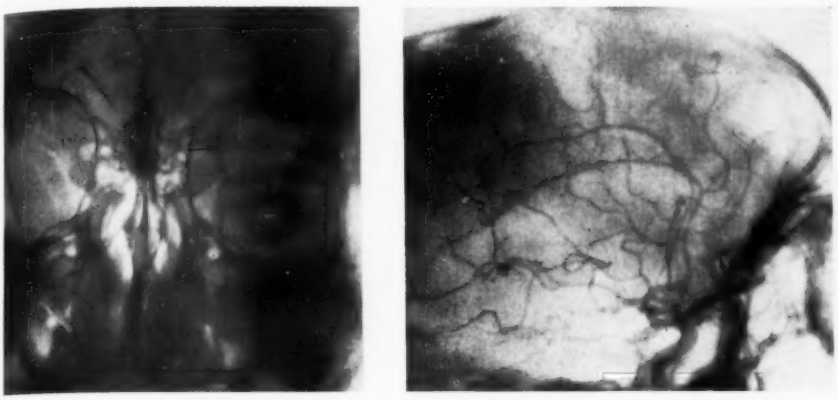

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Fig. 1. Orbital cholesteatoma. a) Sharply defined bone defect at supero-lateral aspect of left orbital cavity. b) Normal arterial phase of left common carotid angiography. Elevation of posterior part of orbital roof on affected side.

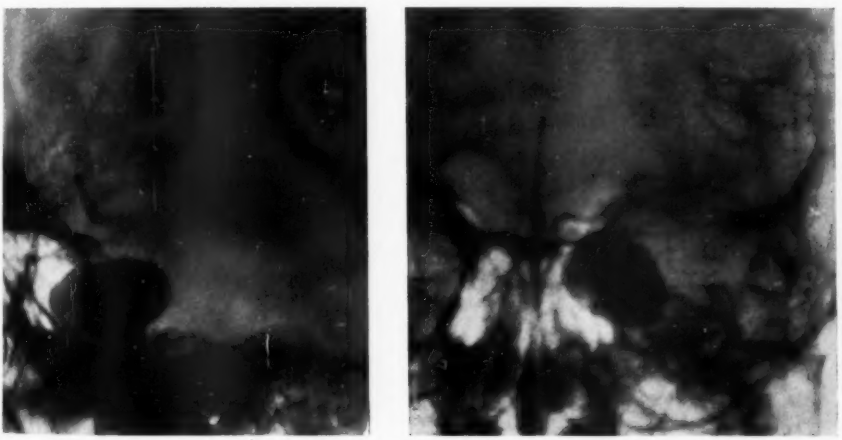

Fig. 2. Aneurysm of intracavernous portion of left internal carotid artery.

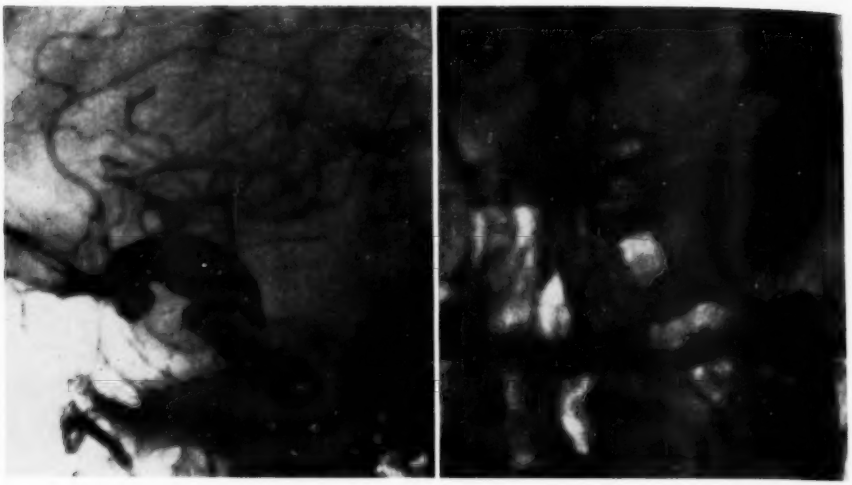

Fig. 3. Diffuse aneurysmal ectasia of left internal carotid artery syphon.

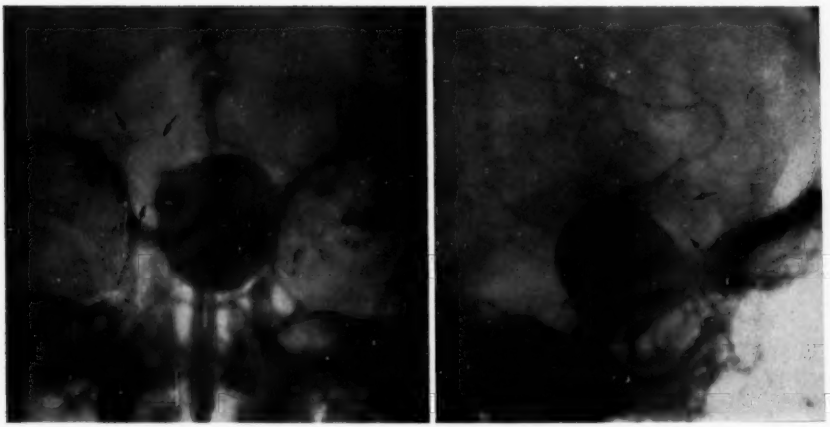

Fig. 4. Another large aneurysm. This is located anteriorly to intracavernous portion of the left internal carotid artery and almost at the midline. Conventional films showed an hourglass-shaped cystic calcification. The supero-lateral part of the calcification (arrows) did not fill.

Fig. 5. Berry aneurysm of right internal carotid artery at origin of posterior communicating artery.

spheno-sphenoidal fissure into the antero-medial part of the middle cerebral fossa was eventually established, the final diagnosis being metastases from a mammary carcinoma. In the other case, one of syphilis with complete ophthalmoplegia, a clinical diagnosis of a parasellar leptomeningeal inflammatory process was made. After appropriate anti-syphilitic treatment the ophthalmoplegia receded. The diagnosis must of course be considered as being only indirectly confirmed.

Among the patients with positive roentgenologic findings was a twenty-year-old girl with moderate exophthalmos and impairment of VI. Visual acuity was perfectly preserved and the disks were normal. Roentgenograms of the skull revealed an area of bone destruction involving the supero-lateral part of the orbital cavity on the ophthalmoplegic side (Fig. 1) and extending to the external aspect of the spheno-sphenoidal fissure; it was the size of a hazelnut and had sharp circular edges with a thin perimarginal sclerotic halo. The posterior part of the affected orbital roof was elevated. A diagnosis of orbital cholesteatoma was made. Angiography of the common carotid artery failed to show any pathologic features (Fig. 1b). Histology eventually proved the growth to be an epidermoid cyst.

In 4 cases the presence of aneurysms of the intracranial portion of the internal carotid artery was demonstrated angiographically (Figs. 2, 3 and

4). Conventional roentgenograms in one instance showed a large erosion of the sella turcica. In another case a huge cystic calcification partly corresponding to the walls of the aneurysm was seen. Carotid angiography on the side opposite to the lesion was carried out in all these four cases. No spontaneous filling of the aneurysmal sac via the contralateral carotid circulation was obtained. In 2 cases in which the anterior cerebral artery did fill via the carotid artery ipsilateral to the aneurysm, both anterior cerebral arteries filled via the contralateral carotid artery. In fact, in one of these two cases, the injection of the contrast medium into the carotid artery contralateral to the ophthalmoplegia caused filling not only of the anterior cerebral artery but also of the middle cerebral system ipsilateral to the lesion. In the other case, in which the anterior cerebral artery filled via the carotid artery homolateral to the aneurysm, it filled via the contralateral carotid artery as well.

The cause of the unilateral ophthalmoplegia in another case was found angiographically to be a berry aneurysm of the posterior communicating artery at the site of its origin in the internal carotid artery (Fig. 5). The conventional films in this case were negative.

The importance of an accurate roentgenographic investigation, including carotid angiography, in every case of unilateral ophthalmoplegia must be strongly emphasized.

SUMMARY

The results of the roentgenologic investigation, including carotid angiography, of eight cases of unilateral ophthalmoplegia are reported.

ZUSAMMENFASSUNG

Die Ergebnisse einer röntgenologischen Studie, einschliesslich der Karotisangiographie in acht Fällen mit einseitiger Ophthalmoplegie werden berichtet.

RÉSUMÉ

Présentation de l'étude radiographique, comprenant l'angiographie carotidienne, de huit cas d'ophtalmoplégie unilatérale.

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SERVICES DE RADIODIAGNOSTIC DE L'INSTITUT J. BORDET (DIRECTEUR: PROF. G. J. MELOT) ET NEUROCHIRURGIE (DIRECTEUR: PROF. P. MARTIN) DE L'UNIVERSITÉ LIBRE DE BRUXELLES, BELGIQUE

LES EXTENSIONS INTRACRANIENNES DES TUMEURS DE L'ETHMOÏDE, DE L'ORBITE ET DU CAVUM

Étude angiographique

par

G. J. Melot, R. Potvliege, J. Brihaye et *Ph. Martin*

L'invasion de la boîte cranienne par les tumeurs malignes à point de départ naso-pharyngé ne constitue nullement une exception. Bien au contraire, elle est considérée comme étant classique. De nombreux travaux, parmi lesquels nous relevons celui de COPPEZ et MARTIN en 1927, lui ont été consacrés.

La pénétration tumorale se produit au travers de la base du crâne soit par destruction du tissu osseux soit par simple infiltration dans les canaux de Havers et dans la spongieuse autour des travées osseuses sans qu'il y ait d'ostéolyse appréciable. Dans d'autres cas, la tumeur emprunte les orifices préformés, orifices par où passent les nerfs et les vaisseaux.

Divers syndromes liés à l'atteinte de tel ou de tel nerf cranien ou plutôt de tel ou de tel groupe de nerfs résultent de l'entreprise néoplasique de la base du crâne. La symptomatologie peut demeurer simple mais tend à une plus grande complexité au fur et à mesure de la progression

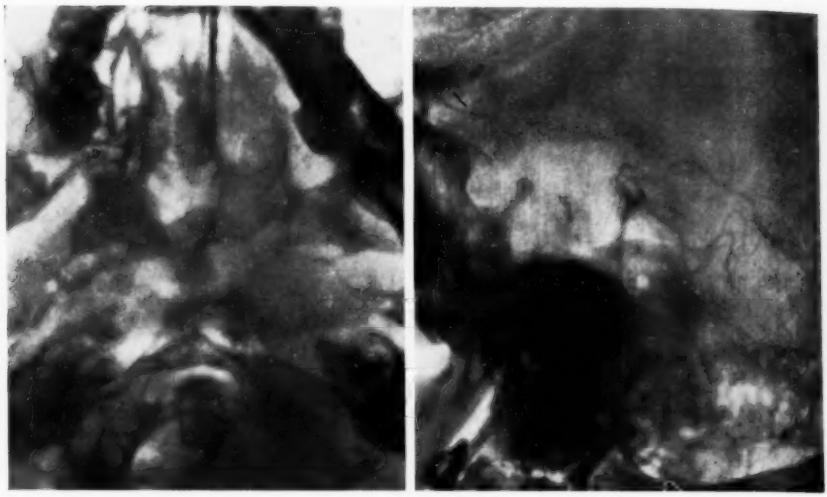

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Fig. 1. Cas 1. a) Opacité des cellules ethmoïdales gauches. Érosion du plancher de la fosse temporale gauche et de la pyramide pétreuse. b) Artériographie de la vertébrale. Refoulement vers l'arrière du tronc basilaire. Déstruction de la lame quadrilatère.

tumorale. Charles Foix a décrit le syndrome de la paroi latérale du sinus caverneux correspondant à une atteinte des nerfs oculo-moteurs et de la branche ophtalmique du trijumeau. Ce syndrome se différencie de celui de l'apex orbitaire par l'intégrité du nerf optique et du syndrome pétro-sphénoïdal par l'absence de névralgie trigéminale de type gassérien. Vernet et Collet-Sicard ont donné leur nom à des entreprises nerveuses postérieures bien caractérisées (IX, X, XI d'une part et IX, X, XI, XII de l'autre). Garcin (7) toutefois a insisté sur l'association fréquente d'un syndrome paralytique des nerfs craniens antérieurs et d'une atteinte semblable des nerfs du groupe postérieur ce qui réalise une paralysie globale unilatérale des nerfs craniens.

La selle turcique et l'hypophyse peuvent être entrepris et détruits ce qui provoque une symptomatologie endocrinienne (diabète insipide par exemple).

La dure-mère de la base résiste dans certains cas à l'envahissement néoplasique. Elle parvient de ce fait à protéger les citernes sous-arachnoïdiennes et le tissu cérébral. Plus souvent elle est entreprise.

A l'intérieur du crâne, la prolifération néoplasique reste quelquefois localisée et forme une masse bien définie qui se comporte comme une lésion expansive. Elle peut aussi réaliser un envahissement diffus non

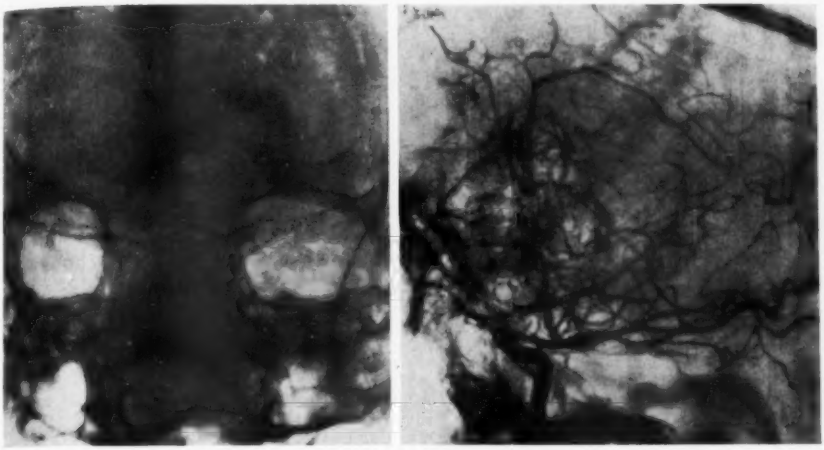

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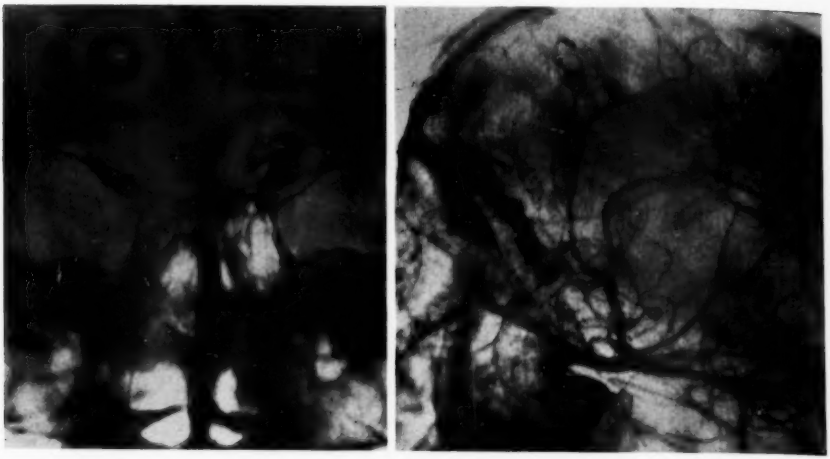
Fig. 2. Cas 2. a) Opacité des fosses nasales, des cellules ethmoïdo-sphénoïdales et des sinus frontaux. Érosion partielle des cloisons ethmoïdales et de la lame criblée. b) Volumineuse tumeur frontale se manifestant par le déplacement des artères cérébrales antérieures et moyennes ainsi que par un vaste foyer de vascularisation pathologique de type malin.

seulement de l'os mais encore des méninges. DAGNELIE en a récemment rapporté une observation. La tumeur était un épithélioma de type cylindromateux à départ palatin. Après propagation régionale, effraction de la base du crâne et de la dure-mère, la néoplasie s'était développée en surface dans la pie-mère, le long de la moelle jusqu'aux racines de la queue de cheval en respectant cette fois la dure-mère.

D'après BACLESSE l'entreprise de la base du crâne fréquente dans les cas d'épithélioma du cavum est rare lorsqu'il s'agit d'un lymphosarcome; une origine métastatique a été signalée dans quelques observations (POTVLIEGE).

L'effondrement de la base du crâne résulte quelquefois du développement régional d'une tumeur à point de départ autre que le rhinopharynx: l'ethmoïde, la fosse temporale, l'orbite par exemple. D'après WALTHER la prolifération intracranienne d'une tumeur née dans l'appareil sinusal serait plus rare que celle qui résulte du développement d'une tumeur d'origine épipharyngée. Les travaux consacrés aux infiltrations parties du massif facial antérieur sont assurément moins nombreux qu'à celles qui proviennent du rhinopharynx. Ainsi dans son traité de neuro-ophtalmologie, WALSH développe largement le chapitre consacré aux envahissements craniens d'origine naso-pharyngée mais ne parle qu'incidemment des proliférations intracraniennes des tumeurs de l'orbite. Il relate un



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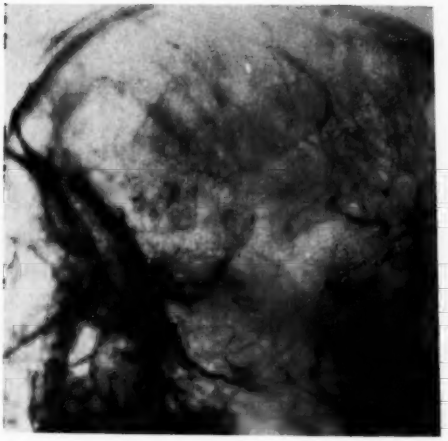

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Fig. 3. Cas 3. a) Opacité de l'ethmoïde droit, érosion partielle de l'os planum. b) Angiographie carotidienne—phase artérielle. Présence d'un foyer de vascularisation pathologique implanté sur la base de la fosse frontale. c) Foyer de vascularisation pathologique baso-frontal — début du retour veineux.

travail de SANDERS qui sur 12 cas de tumeur de la glande lacrymale a 5 fois vu le patient décéder des suites d'une extension intracranienne de la tumeur. Il cite également SCHLIVEK qui a rapporté un cas de tumeur de Schminke étendue aux sinus et de là aux lobes frontaux.

La rareté des publications s'explique peut-être par le fait que le tableau clinique évolue à bas bruit et qu'il ne se manifeste habituellement

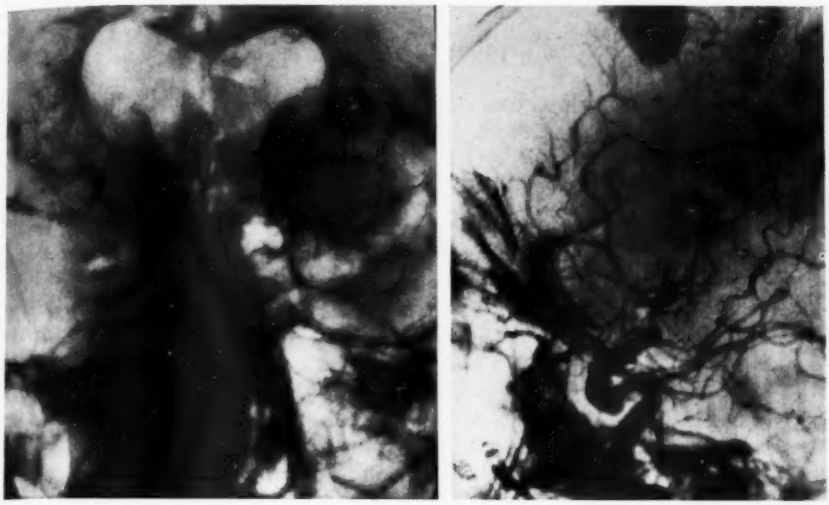

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Fig. 4. Cas 5. a) Opacité de la fosse nasale et des cellules ethmoïdales droites. Érosion partielle des cloisons ethmoïdales et de la lame criblée. Aspect normal des citernes. Absence de déformation des cornes frontales. b) Aspect normal du siphon carotidien, de l'artère cérébrale antérieure et de ses ramifications fronto-basales et fronto-polaires.

qu'assez tard au cours de l'évolution de la tumeur. Un syndrome du trou déchiré postérieur au contraire peut être l'une des toutes premières manifestations cliniques d'un épithélioma du cavum. Il est cependant à noter que la dure-mère est moins épaisse au niveau de la lame criblée que de la fosse temporale et que ses prolongements dans les pertuis par où passent les rameaux nerveux olfactifs la rendent fort fragile. La tumeur qui détruit la lame criblée prolifère dans la fosse frontale en refoulant, parfois même en infiltrant le tissu cérébral. Les signes cliniques qui en résultent consistent essentiellement en une atteinte du nerf olfactif, un syndrome frontal, des modifications du LCR avec hyperalbuminose, éventuellement présence de cellules néoplasiques, parfois des signes d'irritation méningée, d'hypertension intracranienne ainsi que d'entreprise du nerf optique.

La fréquence des tumeurs invasives du crâne paraît peu élevée. Dans sa statistique de 2.000 cas de tumeurs intracraniennes, CUSHING en compte 20 exemples, soit 1 %. Parmi celles-ci, il cite des métastases et des sarcomes de la voûte du crâne, notamment développés sur maladie de Paget. Il ne mentionne pas de tumeur invasive à départ sinusal ni naso-pharyngé.

Diagnostic radiologique

Le diagnostic d'entreprise de la base du crâne peut habituellement être porté par l'examen neurologique. La radiologie le confirme et apporte des précisions sur l'étendue des destructions osseuses d'une part et aussi sur la tumeur primitive. Celle-ci est fréquemment difficile à examiner cliniquement en raison de l'obstruction des fosses nasales, des choanes et aussi de l'état du patient atteint de trismus ou d'hémorragies.

L'examen radiologique sera pratiqué sous de multiples incidences. Les clichés de face, de profil seront complétés par des incidences centrées sur telle ou telle région du crâne. Citons parmi les plus couramment effectuées les incidences de Stenvers, de Schüller, de Towne Bretton, de Waters, de Rhese, de Chaussé. Dans un article récent VANDOR a indiqué quelles étaient les incidences les plus utiles pour chacun des syndromes que pouvait provoquer la prolifération tumorale. Fréquemment il sera fait appel à la tomographie, à la macroradiographie ou à la stéréographie, afin de préciser l'état de la lame criblée, des apophyses ptérygoïdes, des parois du sinus sphénoïdal ou de toute autre structure dont l'entreprise est suspectée.

Il ne faut pas perdre de vue que dans certains cas l'invasion de la base du crâne ne se manifeste pas de façon certaine sur les clichés. Ceci résulte soit d'un stade relativement débutant de l'infiltration soit de son mode de prolifération intraspongieuse qui respecte l'architecture de l'os.

Il peut se révéler utile de compléter les renseignements recueillis sur l'état osseux de la base par des examens qui portent plus précisément sur l'état des structures intracraniennes: ces renseignements nous les obtiendrons soit par cisternographie, encéphalographie ou ventriculographie, soit par angiographie carotidienne ou vertébrale. L'intérêt de ces techniques est de pouvoir mettre en évidence éventuellement un refoulement ou une oblitération des citernes, un déplacement de vaisseaux ou un foyer de vascularisation pathologique.

Nous avons réuni quelques observations de néoplasmes du rhinopharynx, des fosses nasales, de l'ethmoïde et de l'orbite qui illustrent l'intérêt que peut présenter l'angiographie dans le diagnostic d'extension de la tumeur et même dans le diagnostic de sa nature.

Casuistique

Cas 1. N. R. 19 ans. Homme, hospitalisé d'urgence en raison d'importants épistaxis qu'il attribue à un accident de travail survenu cinq semaines auparavant. L'examen clinique révélait l'existence d'une exophtalmie gauche non pulsatile, d'une paralysie unilatérale globale des nerfs craniens avec amaurose et d'une tuméfaction de l'hémiface gauche.

L'artériographie carotidienne (étant pratiquée d'urgence en salle d'opération après dénudation de la carotide commune afin d'être prêt à pratiquer une ligature si l'examen révélait l'existence d'un anévrisme traumatique de la base): Évidence d'un soulèvement du siphon carotidien et du groupe artériel sylvien. Les tissus mous du rhinopharynx tuméfiés. De nombreux petits vaisseaux irréguliers dans le domaine de l'artère maxillaire interne et de la pharyngée ascendante. Diagnostic de tumeur du rhinopharynx avec effondrement de la base du crâne et prolifération intracranienne.

Radiographie du crâne: Tuméfaction du cavum, opacité des cellules ethmoïdales et sphénoïdales. Diminution de la transparence du sinus frontal et maxillaire gauche. Élargissement de la fente sphénoïdale. Érosion étendue du plancher de la fosse temporale, entreprise du rocher et du trou déchiré postérieur ainsi que de la paroi postérieure de la selle turcique.

Angiographie vertébrale: Redressement et refoulement vers l'arrière de l'artère basilaire.

Examens: O. R. L. (Blavier), infiltration sous-muqueuse étendue des parois supérieure et latérale gauche du cavum. Bourgeonnement tumoral dans la fosse nasale gauche; Ophtalmologique (Danis), amaurose gauche, exophtalmie gauche, anesthésie cornéenne, ophtalmoplégie gauche. Netteté des bords de la papille gauche, décoloration de son segment temporal; E. E. G. (Hasaerts), dysrythmie généralisée à prédominance frontale gauche; Histologique (Gompel) (biopsie du cavum), carcinome indifférencié.

Traitement: Ligature de la carotide externe en raison d'une reprise des hémorragies nasales. *Radiothérapie* (Simon): régression manifeste de la tumeur tant dans le cavum que dans les fosses nasales. Recalcification partielle de la base du crâne. Pas de récidive 5 mois après la fin du traitement mais généralisation carcinomateuse quelques semaines plus tard.

Résumé: Syndrome de Garcin typique par prolifération intracranienne d'une tumeur maligne du rhino-pharynx. L'étendue de l'invasion du crâne a été révélée par l'artériographie carotidienne et vertébrale qui a permis d'éliminer le diagnostic d'anévrisme traumatique de la base. Des vaisseaux néoplasiques se distinguent dans le territoire irrigué par les branches de la carotide externe. Le L. C. R. est fortement altéré.

Cas 2. H. L. 53 ans. Homme hospitalisé à l'Institut J. Bordet en raison du développement d'une tumeur occupant les deux fosses nasales et détruisant les os propres du nez. La tumeur évolue depuis plus d'un an, elle s'étend aux choanes et à l'ethmoïde. Sa nature histologique est celle d'un fibrosarcome polymorphe (Périer).

Un traitement radiologique (Simon) est appliqué au patient. Bien que 6.000 r aient été donnés à la tumeur en sept semaines par 3 champs, il ne se produit pas de régression. Deux mois après la fin du traitement, il est pratiqué une ethmoïdectomie élargie avec évidement des fosses nasales et résection de la cloison (Smets, Blavier). Au cours de l'intervention, il est constaté que la lame criblée est détruite et que la tumeur arrive au contact des lobes frontaux. Les suites opératoires sont compliquées par une réaction méningée avec céphalées, signes de Lasègue +, légère stase papillaire, altération du LCR (alb. 0.60 gr ‰, Ravaud +, 38 éléments dont 85 % de lymphocytes). Elle s'accompagne d'une suppuration nasale dans laquelle les cultures bactériologiques isolent des staphylocoques pathogènes, des entérocoques et des bacilles pyocyaniques. Le traitement aux antibiotiques permet de juguler l'infection.

Le patient reste sans récidive apparente pendant 18 mois puis il développe des troubles de la mémoire, de l'indifférence affective et une désorientation spatio-temporelle ainsi qu'un syndrome pyramidal droit. L'examen ORL montre une récidive locale de la tumeur à gauche. L'examen ophtalmologique (Danis) décèle un syndrome de névrite rétro-bulbaire gauche avec chute à 1/10 de l'acuité visuelle. Les champs sont imprenables. EEG dysrythmie lente généralisée à prédominance centro-temporale gauche.

Radiographie du crâne: Opacité de l'ethmoïde et des sinus frontaux. Effacement de la paroi interne des orbites. Disparition de la cloison nasale et des cornets.

Angiographie gauche, injection de la carotide interne: Aplatissement du siphon. Abaissement du groupe sylvien. Redressement et refoulement vers l'arrière de la cérébrale antérieure et de la péricalleuse. Opacité de l'artère ophtalmique. Mise en évidence d'un volumineux foyer de vascularisation pathologique de 6 cm de diamètre environ développé sur la base de l'étage frontal. Les vaisseaux: d'aspect anarchique, leur calibre et leur disposition irréguliers, la tumeur mal délimitée, présentant une imprégnation peu homogène par le produit de contraste. Il n'y a pas de retour veineux précoce. La cérébrale antérieure déplacée et incurvée vers la droite. Les vaisseaux tumoraux proviennent de la cérébrale antérieure et de l'artère ophtalmique par l'intermédiaire des ethmoïdales.

Angiographie droite: Des plages de vascularisation tumorale dans l'hémisphère droit également, moins importants qu'à gauche mais d'aspect semblable.

Résumé: Sarcome polymorphe de la cloison ethmoïdo-nasale évoluant depuis plus d'un an avant le traitement. Celui-ci a consisté en radiothérapie suivie d'une exérèse chirurgicale. 18 mois plus tard le patient présente un syndrome frontal et un syndrome pyramidal qui révèlent l'existence d'une entreprise intracranienne. L'importance de celle-ci est établie par l'angiographie qui met en évidence non seulement des déplacements vasculaires mais encore des foyers de vascularisation pathologique de type malin.

Cas 3. C. A. 27 ans. Le début clinique de l'affection remonte à 1952. Développement d'une tumeur dans l'angle interne de l'orbite droite. Examen ophtalmologique (DELAET): Légère congestion veineuse au niveau de la papille droite avec pouls veineux spontané. Acuité visuelle normale. À l'exophtalmomètre: à droite 22, à gauche 21.

Radiologie: Evidence d'une diminution de la transparence de l'ethmoïde, du sinus frontal et du sinus maxillaire droit ainsi qu'un effacement de la lame criblée, de l'os planum et des cloisons ethmoïdales. La biopsie pratiquée avant l'hospitalisation à l'Institut Bordet, conclut à un angiome histocytaire.

En octobre 1952: Ethmoïdectomie élargie (CORYN, SCHUERMANS, BLAVIER). L'examen de la pièce d'exérèse montre un tissu angiomateux à stroma assez développé formé de cellules mésenchymateuses indifférenciées (DUSTIN).

Devant l'importance des altérations osseuses révélées par l'examen radiologique et confirmées au cours de l'intervention, il est décidé de compléter le traitement par de la radiothérapie (SIMON) suivant la technique de Baclesse. Le patient reste sans récidive jusqu'en 1956. A ce moment, il se produit une reprise de l'exophtalmie. L'examen ophtalmologique conclut à une névrite rétrobulbaire. Les altérations osseuses sont pratiquement inchangées depuis le premier contrôle post-opératoire. Il n'existe pas de signes cliniques d'envahissement du crâne bien que le patient se plaigne parfois de céphalées.

Une *angiographie carotidienne* est demandée afin de vérifier le diagnostic d'angiome.

La ponction intéresse la carotide interne. Elle met en évidence un foyer de vascularisation pathologique implanté sur le plancher de la fosse frontale et refoulant la cérébrale antérieure. Les vaisseaux qui constituent le foyer sont minces et réguliers. Il n'y a pas de stase ni de shunt artérioveineux. Une veine incurvée délimite le foyer vers l'arrière. L'artère rolandique, bien que cheminant à distance de la lésion, est également incurvée vers l'arrière. Les vaisseaux frontaux antérieurs se remplissent mal et paraissent étirés.

L'existence d'une prolifération intracranienne étant démontrée ainsi que celle d'une récidive intra-orbitaire, la tumeur révélée de croissance lente et de nature histologique bénigne, il est décidé de tenter une exérèse complète de la tumeur par une double intervention. Un volet frontal droit est pratiqué en mai 1956 (BRIHAYE, MARTIN). Le cortex frontal se montre tendu, sa vascularisation de surface est anormale, les artères sont ortueuses, les veines déplacées. Une lobectomie du pôle frontal met la tumeur en évidence.

Elle est largement adhérente au plafond de l'orbite et à la lame criblée. Elle est bien encapsulée, ses contours sont mamelonnés. L'aspect macroscopique rapelle celui d'un méningiome olfactif à dévelopement latéral. La tumeur atteint 3 cm d'épaisseur, elle s'étend jusqu'à la citerne chiasmatique. Elle est réséquée en bloc avec le plafond de l'orbite qui est infiltré. La trépanation de l'orbite permet de constater que la tumeur est compacte et qu'elle enserre le globe oculaire. Les sinus ethmoïdaux et frontaux envahis sont curetés. Le nerf optique est sectionné près du chiasma et l'artère ophtalmique clipée afin de préparer le 2e temps. Une réfection du plafond orbitaire est effectuée par une large greffe aponévrotique. Le 2e temps est pratiqué 2 semaines plus tard. Il consiste en une exentération de l'orbite (SMETS, DELAET).

L'examen histologique de la pièce opératoire conclut cette fois à un sarcome polymorphe à structure périthéliale avec plages d'ostéochondrosarcome (DUSTIN). Il est à noter que l'interprétation des préparations suscite des discussions, certains pathologistes penchant plutôt vers le diagnostic de tumeur mixte de la glande lacrymale (GOMPEL, STEWART).

L'importance des doses de rayons roentgen appliquées en 1952 ne permet pas de nouvelles irradiations. Une récidive orbitaire apparaît 4 mois après l'intervention.

Résumé: Tumeur née aux confins de l'ethmoïde et de l'orbite récidivant 4 ans après exérèse et radiothérapie. Une angiographie pratiquée afin de vérifier un diagnostic histologique d'angiome révèle l'existence d'une prolifération intracranienne se manifestant par des déplacements vasculaires et un foyer de néoformation vasculaire de type apparemment bénin.

Cas 4. B. F. 62 ans. Ce patient est admis en septembre 1956. Il présente une tumeur de la fosse nasale droite, obturant la choane et provoquant un empâtement de la joue. L'affection a débuté il y a près d'un an. La biopsie démontre sa structure adénocarcinomateuse (GOMPEL).

Les *radiographies du crâne* révèlent l'opacité de la fosse nasale, des sinus frontaux, ethmoïdaux et maxillaire droits, la destruction des cloisons ethmoïdales, l'effacement de la lame criblée et de l'os planum du côté des lésions sinusales.

Examen ophtalmologique (DE LAET): position et motilité normales des globes oculaires. Amputation du secteur nasal et rétrécissement concentrique du secteur temporal du champ visuel droit. Aspect normal du fond d'oeil droit mais taches pigmentaires vraisemblablement congénitales à gauche. En conclusion: compression du nerf optique entre le chiasma et le point de pénétration des vaisseaux centraux de la rétine.

Au cours de son hospitalisation, le patient développe des troubles confusionnels, il se plaint de céphalées et présente de la désorientation spatio-temporelle. Il est transféré dans le service de Neurochirurgie. EEG (HASAERTS): dysrythmie lente généralisée. Bouffées d'ondes théta et delta fronto-centrales à prédominance droite.

Une *encéphalographie* est tentée afin de vérifier l'existence d'une prolifération intracranienne. La P. L. révèle l'existence d'une hypertension considérable à plus de 80 cm d'eau. 10 ml d'air sont injectés. Ils mettent en évidence un défaut de remplissage du plancher et de la face interne de la corne frontale gauche. Le ventricule droit n'est pas visualisé. Le septum lucidum et le 3e ventricule sont légèrement refoulés vers la gauche. L'analyse du LCR prélevé au cours de l'encéphalographie donne pour résultat: albumine 0.50 gr $^0/_{00}$, Ravaud et Pandy + Weischbrodt. Numération 5.6 éléments, Polynucléaires 85 $^0/_0$.

Angiographie, injection de la carotide commune: La cérébrale antérieure soulevée dans son segment horizontal, refoulée et incurvée vers la droite dans son trajet ascendant. De petites artérioles régulières se distinguent dans la concavité de la boucle décrite par la C. A. au dessus de la base du crâne. Il n'y a pas d'anarchie vasculaire ni de stase,

ni de shunt artério-veineux décelable. Les branches de la carotide externe sont régulières, il n'y a pas de foyer de vascularisation pathologique décelable au niveau de la tumeur de l'ethmoïde et des fosses nasales.

Intervention chirurgicale (P. MARTIN—PH. MARTIN). Volet frontal droit. Hypertension importante. Lobectomie de la pointe du lobe frontal droit. La tumeur est dure, mamelonnée, bien encapsulée. Elle a pénétré dans le crâne par la lame criblée à droite de la faux et envoie un large prolongement à gauche, sous la faux. La tumeur est enlevée par morcellement au ras de l'ethmoïde. La faux est ensuite rabattue sur la surface cruentée de façon à isoler la cavité cranienne de la tumeur de l'ethmoïde.

Les suites opératoires furent orageuses et aboutirent au décès du patient. L'examen post mortem (ZYLBERSZAC) montre une tumeur faite de tissu friable envahissant tout le sinus ethmoïdal et tout le sinus sphénoïdal. La closion ethmoïdale est rongée, le vomer détruit. A l'intérieur du crâne, la tumeur se prolonge jusqu'à la loge hypophysaire et les bandelettes optiques. L'examen du cerveau (PÉRIER) confirme l'existence d'une coulée néoplasique dans les méninges molles. Le tissu cérébral n'est pas infiltré.

Résumé: Adénorcarcinome de l'ethmoïde évoluant depuis 1 an et s'extériorisant à l'orbite et au sinus maxillaire. L'invasion de la base du crâne se manifeste par de la confusion mentale, des troubles de l'EEG et des altérations du LCR. Elle fut démontrée par l'angiographie qui révèle l'existence de déplacements vasculaires et d'une vascularisation pathologique baso-frontale.

Après ces quatre observations qui se rapportent à des proliférations malignes invasives, nous croyons intéressant de rapporter un cas de tumeur du massif facial où l'examen radiologique à permis d'éliminer l'hypothèse d'une entreprise tumorale intracranienne.

Cas 5. G. V. 76 ans. La patiente présente une volumineuse tumeur comblant la fosse nasale droite. La région des os propres du nez et l'angle interne de l'orbite sont tuméfiés. Le globe oculaire est refoulé vers le dehors. La cloison nasale est déviée vers la gauche.

Radiographie du crâne (clichés standards et tomographies) montre un obscurcissement des sinus de l'hémiface droite et une érosion des cloisons ethmoïdales et de la lame criblée. Une partie de l'os planum est refoulée dans l'orbite, une partie de la cloison nasale déplacée dans la fosse nasale gauche.

L'aspect clinique est celui d'une volumineuse tumeur de l'ethmoïde ayant envahi la fosse nasale est s'extériorisant largement au niveau de l'orbite droite.

La biopsie conclut à un angiome infecté ou à du tissu de granulation angiomateux (DUSTIN).

Une *angiographie* est demandée afin de vérifier ce diagnostic. L'injection de produit de contraste est pratiquée dans la carotide commune. Les artères cervicales et cérébrales sont allongées et sinueuses. Il n'y a pas de déplacement vasculaire ni de foyer de vascularisation pathologique décelables sur les clichés pris en séries de face et de profil.

Le diagnostic d'angiome mis en doute, il restait à vérifier l'éventualité d'une prolifération intracranienne. Ceci se fait par une encéphalographie fractionnée. Les citernes de la base sont perméables et de forme normale, en particulier au niveau du chiasma et des citernes olfactives. Les ventricules latéraux sont en place, symétriques mais légèrement élargis.

L'intégrité des espaces sous-arachnoïdiens est confirmée par l'analyse du LCR prélevé au cours de l'encéphalographie: albumine 0.25 gr $^0/_{00}$, éléments 1.6 par mm^3, lymphocytes 50 %.

Intervention chirurgicale: ethmoïdectomie élargie (SMETS, BLAVIER, DOR). La tumeur se laisse aisément enlever en bloc. Elle envahit complètement l'ethmoïde, la fosse nasale, les deux tiers internes de l'orbite et tout le sinus maxillaire dont les parois externe et postérieure ne semblent pas entreprises. Après énucléation de la tumeur, on constate la destruction du plancher du sinus frontal droit, la disparition de la cloison séparant les sinus frontaux, la colonisation de ces sinus par un bourgeonnement tumoral et la destruction de la lame criblée.

Examen histologique de la pièce: fibromyxome à potentialités malignes très faibles (DUSTIN). Près de deux ans après l'intervention, la patiente est toujours en vie sans signe de récidive.

Résumé: L'examen angiographique pratiqué chez cette patiente a tout d'abord permis d'éliminer l'hypothèse d'angiome suggérée par l'examen d'un prélèvement biopsique au niveau du bourgeon nasal de la tumeur. Il a ensuite montré l'absence de déplacement vasculaire et de foyer tumoral intracranien. Ceci fut vérifié d'abord par une pneumographie puis par l'intervention chirurgicale.

Discussion

Le relevé de nos observations permet quelques constatations.

Du point de vue clinique, l'entreprise de la base du crâne se manifestait chez l'un de nos patients par un syndrome de paralysie unilatérale globale des nerfs craniens, chez un autre par un syndrome frontal combiné à un syndrome pyramidal. Ce dernier syndrome est de constatation exceptionnelle d'après Garcin dans les entreprises néoplasiques de la base. Un troisième malade présentait de la confusion mentale. Le quatrième ne montrait aucun signe d'envahissement intracranien et la découverte de la prolifération suscita une réelle surprise. Dans les trois cas où il fut effectué, l'examen du LCR se révéla des plus significatifs en relevant une hyperalbuminose de 0.50 à 5 gr. Il existait dans ce dernier cas une dissociation albuminocytologique typique avec coagulation spontanée du liquide sans cellules néoplasiques présentes. L'examen ophtalmologique révéla trois fois sur quatre l'existence d'une névrite optique et même d'amaurose. Une papille de stase ne fut mise en évidence qu'une seule fois (Cas 2). Elle fut transitoire et liée à des phénomènes méningés inflammatoires survenus après curetage de l'ethmoïde. L'existence d'une hypertension intracranienne fut toutefois découverte chez un autre patient par la manométrie pratiquée en cours d'encéphalographie (Cas 4). Garcin avait souligné la rareté de l'hypertension qu'il attribuait à la décompressive spontanée que réalise l'effondrement néoplasique de la base du crâne.

Un examen EEG fut pratiqué chez 3 patients. Il montre dans chacun des cas l'existence d'une dysrythmie lente généralisée et chez l'un des malades (Cas 4) des bouffées d'ondes théta et delta fronto-centrales pathognomoniques d'un foyer expansif.

Le diagnostic radiologique de l'infiltration osseuse de la base du crâne a été fait dans chacun de nos cas. Il révéla chez le jeune patient au syn-

drome de Garcin de vastes plages érosives confluentes étendues de la grande aile sphénoïdale jusqu'au trou déchiré postérieur. Chez les autres malades les destructions osseuses intéressaient surtout le massif facial mais chaque fois la lame criblée était effacée.

L'angiographie a été pratiquée chez l'un de nos patients afin d'éliminer la possibilité d'un anévrisme traumatique de la base. Chez deux autres patients, elle a été effectuée afin de vérifier un diagnostic biopsique d'angiome.

L'existence de l'infiltration intracranienne a été démontrée dans les 4 observations positives par des déplacements vasculaires indiscutables. Une fois la tumeur était richement vascularisée et montrait des vaisseaux irréguliers d'aspect anarchique sans qu'il y ait de retour veineux précoce. Une autre fois, il n'y eut pas de vaisseaux visibles dans la masse tumorale. Les deux autres cas montraient de fins vaisseaux de calibre régulier mais de disposition anormale; dans l'un de ces cas, il existait un vaisseau périphérique étiré au dessus de la lésion et une disposition anormale des artères et des veines frontales qui fut d'ailleurs retrouvée à l'intervention (Cas 3).

La prolifération tumorale étant implantée sur la base du crâne peut poser des problèmes de diagnostic différentiel d'avec les méningiomes, en particulier d'avec le méningiome olfactif. Dans son compte rendu opératoire, l'un de nous mentionne la similitude entre l'aspect macroscopique de la tumeur maligne et un méningiome de l'étage antérieur (Cas 3). L'angiographie nous a permis d'observer des déplacements de vaisseaux semblables à ceux qui se rencontrent lorsqu'il existe une tumeur basale, mais nous n'avons pas observé l'imprégnation persistante caractéristique du méningiome, imprégnation apparaissant à la phase intermédiaire et se maintenant au cours du retour veineux. Il est vrai que d'après WICKBOM, 8 méningiomes seulement sur les 39 cas étudiés présentaient des caractéristiques vasculaires pathognomoniques.

La notion de continuité entre la tumeur primitive et la prolifération intracranienne différencie les extensions directes, loco-régionales des vraies métastases. Celles-ci présentent des images angiographiques variées dont la gamme s'étend de la plage expansive avasculaire au foyer d'aspect gliomateux allant de la classe V de WICKBOM, et même à l'image de méningiome avec stase prolongée et apport sanguin d'origine carotidienne externe (GLOMING, ETHELBERG et VAERNET).

Il est à remarquer également que la vascularisation de la tumeur primitive n'apparaît pas nettement dans notre série de cas même lorsque la carotide commune a été injectée. Cette constatation serait bien entendu à vérifier chez un nombre de patients plus élevé et autant que possible par des angiographies de la carotide externe, pratiquée avant traitement, que celui-ci soit chirurgical ou radiologique. Les auteurs

portugais, et Dos Santos en particulier, ont insisté sur la régression des foyers vasculaires pathologiques au cours de la radiothérapie (Wellauer).

Conclusion

Le nombre trop réduit de nos observations et la variabilité des étiologies ne permettent pas de définir une image angiographique typique des envahissements craniens par des tumeurs nées dans les régions adjacentes de la base. Les cas que nous avons rapportés démontrent cependant que ces envahissements se manifestent par des déplacements d'artères et de veines et aussi quelquefois par des foyers de néoformation vasculaire, pouvant être de caractère malin.

Notre casuistique nous paraît illustrer l'intérêt que présente l'angiographie dans certains cas de tumeurs malignes du massif facial et du rhinopharynx en confirmant la présence d'une prolifération tumorale intracranienne suspectée par la clinique ou en révélant son existence alors qu'elle n'avait encore donné lieu à aucune symptomatologie. Elle attire également l'attention sur un domaine encore trop peu étudié, celui de l'angiographie de la carotide externe appliquée à l'examen des tumeurs du massif facial.

RÉSUMÉ

La fréquence de l'extension des tumeurs malignes du cavum vers l'endocrâne est bien connue. Par contre, l'extension à la fosse frontale des carcinomes à point de départ ethmoïdien ou ethmoïdo-orbitaire a été moins fréquemment rapporté. Cette rareté pourrait s'expliquer par l'évolution à bas bruit et par l'apparition tardive des signes cliniques. Les auteurs ont appliqué l'angiographie carotidienne et vertébrale ainsi que la pneumographie à l'étude d'un certain nombre de tumeurs développées au niveau du versant exocranien de la base. Ces techniques leur ont permis de démontrer des proliférations intracraniennes à départ rhinopharyngé, nasal, ethmoïdien et ethmoïdo-orbitaire méconnues ou insoupçonnées par la clinique.

SUMMARY

The frequency of infiltration of malignant tumours of the rhino-pharynx towards the endocranium is recognized although the involvement of the frontal fossa by carcinomas of ethmoidal or ethmoido-orbital origin has been reported less often. The latter fact may be explained by the silent development period and by the late appearance of clinical signs. The authors used carotid and vertebral angiography as well as pneumography in the study of tumours which were situated at the base of the skull. These methods permit intracranial growths of rhino-pharyngeal, nasal, ethmoidal, and ethmoido-orbital origin, which have not been suspected clinically, to be demonstrated.

ZUSAMMENFASSUNG

Die Häufigkeit der Extension maligner Tumoren des Nasopharynx in Richtung des Endokraniums ist wohlbekannt. Andererseits ist die Extension von Karzinomen, die vom Os ethmoidale oder dem ethmoidoorbitalen Gebiet ausgehen, weniger häufig berichtet worden. Dieser Mangel konnte durch die schleichende Entwicklung und durch das späte Auftreten klinischer Befunde erklärt werden. Die Verfasser benutzten die Karotis- und die Vertebralisangiographie sowie die Pneumographie beim Studium einiger Tumoren, welche an der exocranialen Seite der Schädelbasis auftreten. Diese Untersuchungsmethoden ermöglichten es, intrakranielle Geschwülste rhinopharyngealen, nasalen, ethmoidalen und ethmoido-orbitalen Ursprunges nachzuweisen, welche bei der klinischen Untersuchung nicht erkannt oder vermutet worden sind.

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CHANGES IN CEREBRAL CIRCULATION DURING CAROTID ANGIOGRAPHY WITH SODIUM ACETRIZOATE (TRIUROL) AND SODIUM DIATRIZOATE (HYPAQUE)

An experimental study

by

Erik Kågström, *Percy Lindgren* and *Gunnar Törnell*

Cerebral angiography has become an indispensable aid in the neurological diagnosis. Severe complications may occur, though infrequently, but minor subjective as well as objective side-effects are quite common. Pharmacologically, the contrast media cannot be regarded as blameless for there are numerous reports on their effects on such factors as the cerebral circulation, blood-brain barrier, electroencephalogram, motor and sensory functions, systemic blood pressure, heart rate, etc.

The results of earlier investigations regarding the brain circulation during carotid angiography are inconsistent. Most of the conclusions are based on direct observation of the pial vessels in animals through a Forbes window. Using a similar technique BROMAN and OLSSON found in experiments in rabbits that contrast media of the diodone type retarded the flow velocity in the pial vessels, probably due in part to the higher viscosity of the contrast medium and partly to vasoconstriction. FOLTZ

et coll. observed severe vasospasm in the arterioles after the injection of Diodrast 35 and 70 %; it lasted a few seconds and was followed first by cortical pallor for 60 to 90 seconds and then by cortical blush for 1 to 2 minutes.

BASSETT et coll. on the other hand were unable to detect any changes in the calibre of the pial vessels in dogs and rabbits after the injection of Diodrast 35 and 70 %, Urokon 70 %, and Thorotrast 35 %. These authors, however, used such enormous doses, 50 ml and more, that their investigations cannot be accepted as of major importance from the pharmacologic and clinical points of view. BROWNE and STERN found in cats that the pial vessels usually reacted with immediate transient dilatation to the injection of Diodrast 35 and 70 %. SCHMIDT (1955) detected no vascular spasm following the injection of a number of contrast media which, however, in high concentrations caused vasodilatation and slowing of the circulation.

BLOOR et coll., using a thermoelectric method for the recording of the cerebral blood flow, reported vasodilatation in the brain after the intracarotid injection of Diodrast. Quite recently INGVAR and SÖDERBERG investigated the intracerebral vascular effects of Umbradil in cats by recording the venous outflow from the superior sagittal sinus. Umbradil 35 % (0.15 ml/kg) injected into the common carotid artery reduced the blood flow from the sagittal sinus by 10 to 25 %, which reduction, according to the authors, 'can be due only to cerebral vasoconstriction'.

Two fairly new contrast media, sodium acetrizoate (Triurol) and sodium diatrizoate (Hypaque), were recently investigated pharmacologically in cats by LINDGREN and TÖRNELL as to their vascular effects during peripheral angiography (via the femoral artery). The authors found that even small doses of sodium acetrizoate (0.05 to 0.2 ml) caused an enormous increase in blood flow of up to ten times and with a duration of 10 to 15 minutes before the initial level was restored. Sodium diatrizoate produced only moderate vasodilatation of short duration. Reference should be made to that paper for other investigations on non-cerebral vessels.

In the light of the observations made by LINDGREN and TÖRNELL, the present investigation was conducted in order to ascertain whether sodium acetrizoate and diatrizoate, given intra-arterially, produced the same vascular effects in the brain as in the skeletal muscles and intestine.

Method

The experiments were performed in 10 cats (1.5 to 4.0 kg) under Dial (40 to 60 mg/kg) or chloralose-Urethane anesthesia (50 + 500 mg/kg).

The arterial blood pressure was recorded in the femoral artery, which was cannulated and connected to an ordinary mercury manometer.

Measurement of the cerebral blood flow presents a very difficult problem and the fact that various methods have been tried indicates that the ideal method has not been found. Because it is continuous and direct, we employed the drop-recording method that was described by CLEMENTZ and RYDBERG and LINDGREN and UVNÄS and which has been used for several years in the Pharmacologic Department. A similar method was recently used by INGVAR and SÖDERBERG (1956) for measuring the outflow from the sagittal sinus in the cat. These authors found the method quite suitable for studying the cerebral circulation and the effect of drugs upon it. (Cf. INGVAR and SÖDERBERG 1957.)

In principle the method consists in directing the blood from a cannulated vein via a plastic tube to a phototube drop counter. The records, directly proportionate to the drop intervals and indirectly proportionate to the rate of flow, are calibrated in milliliters per minute. The orifice of the plastic tube is placed at the same level as the vein, so that the flow runs only against atmospheric pressure (the original modification by CLEMENTZ and RYDBERG). The blood is collected and reinfused by continuous intravenous drip into the femoral vein of the animal.

After making a longitudinal opening in the skull, 5 to 10 mm in width from the occipital suture as far rostrad as possible, a plastic tube was inserted into the sagittal sinus about 10 mm anterior to the occipital suture, as described in detail by INGVAR and SÖDERBERG (1956). In order to prevent clotting, the animals were heparinized, a 5 % solution (25 mg/kg) being given intravenously.

The 50 per cent solutions of contrast media were injected in volumes of 0.2 and 0.4 ml into the common carotid via a very thin polythene tube inserted into the proximal end of the severed superior thyroid artery or a muscular branch at the same level. In three experiments intracarotid injections were given unilaterally; in the remainder the animals were prepared for bilateral injections but the substances were injected only on one side at a time.

The sodium acetrizoate (sodium 3-acetylamino 2, 4, 6-tri-iodobenzoate) used in this study is the Swedish commercial preparation Triurol (Leo). (Sodium acetrizoate is also marketed under the proprietary names of Acétiodone, Diaginol, Rheopak, Urokon.) The commercial name of the sodium diatrizoate (sodium 3,5-diacetylamino 2, 4, 6-tri-iodobenzoate) is Hypaque (Winthrop).

Results

In all experiments the systemic blood pressure and the venous outflow from the superior sagittal sinus were recorded. There was invariably a substantial difference between the two contrast media with regard to their effects on the cerebral blood flow. In no experiment did sodium diatrizoate (Hypaque) produce any significant change in the blood flow through the sagittal sinus, whereas sodium acetrizoate (Triurol) in many instances gave rise to a 100 to 300 per cent increase.

A typical experiment is illustrated in Fig. 1. The injection of 0.4 ml Triurol 50 % into the right common carotid artery was immediately followed by an increase in the outflow from the sagittal sinus. From an initial level of 1.8 ml per minute the flow rose in the course of 10 to 30 seconds to 6.5 ml per minute, *i. e.* it increased by more than 250 per cent. After remaining at this level for 4 minutes, it gradually decreased and returned to the initial level 10 minutes after the injection. Immediately

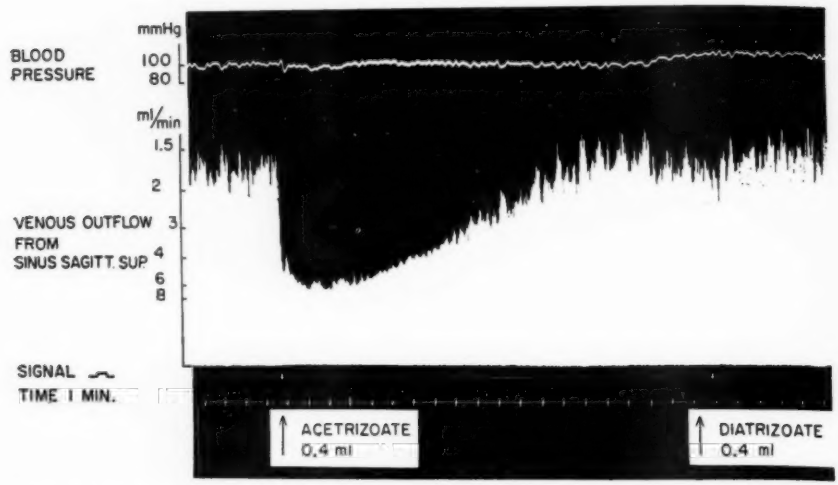

Fig. 1. Cat 4.0 kg. Chloralose — Urethane 50 + 500 mg/kg. Comparison of the effects on the cerebral blood flow of Triurol (sodium acetrizoate) and Hypaque (sodium diatrizoate) injected into the common carotid.

after the injection there was a transient fall of 10 mm Hg in the systemic blood pressure, which was thereafter constant.

A corresponding injection of 0.4 ml Hypaque 50 % did not give rise to any changes, either in the outflow from the sagittal sinus or in the systemic blood pressure.

We have chosen to call this experiment typical, but we would emphasize that the Triurol response was not entirely constant. In several cases we found no increase of flow whatsoever after the injection of the smaller dose of 0.2 ml; we had to give 0.4 ml to obtain an effect, and in a few instances even that dose was ineffective. Quantitatively identical responses were in no case obtained after injections on the right and the left sides. On the contrary, the injection of 0.2 to 0.4 ml of Triurol into one carotid artery not infrequently failed to change the outflow from the sagittal sinus, while a corresponding injection into the contralateral carotid was followed by a marked increase in the flow. (The reasons for this are discussed below.) Noteworthy is the fact that although sometimes no increase of flow occurred, a distinct blood pressure response was as a rule observed.

The response to Hypaque was fairly uniform and not very impressive. The greatest increase of flow observed was 20 to 30 per cent; in the majority of cases, injection of this agent had no effect on the outflow from the superior sagittal sinus.

A flow response indicating cerebral vasoconstriction when sodium acetrizoate or sodium diatrizoate was injected into the common carotid, was never observed.

The results of the experiments are collected in the Table below, which clearly shows the difference in vasodilator properties of the two contrast media, notwithstanding the wide dispersion of the sodium acetrizoate responses. A striking feature of a sodium acetrizoate response is the long duration of the effect on the flow. In a few cases the duration was 30 minutes, and the average duration of effects with more than a 100 per cent increase of blood flow was about 15 minutes.

The Hypaque injections were much fewer than those of Triurol for the injection of the former was only given in close relation to a clearly positive Triurol (sodiumacetrizoate) response and with an identical technique (injection on the same side and with the same volume). The injection was usually given between two positive sodium acetrizoate injections.

Results from 10 experiments with 60 injections of Triurol and 16 injections of Hypaque

Increase of flow in per cent of the initial level	Sodium Acetrizoate (Triurol 50 %)				Sodium Diatrizoate (Hypaque 50 %)			
	0.2 ml		0.4 ml		0.2 ml		0.4 ml	
	No. of injections	Duration min.	No. of injections	Duration min.	No. of injections	Duration min.	No. of injections	Duration min.
0	10	—	5	—	5	—	7	—
0—50	10	1.1	6	1.0	2	0.8	2	1.0
50—100	5	4.6	6	5.0				
100—150	2	12.0	6	16.9				
150—200	2	17.5	5	13.3				
200—			3	14.7				

Discussion

Interpretation of our findings is made somewhat difficult by several factors, not the least being the fairly complicated anatomy of the carotid artery in the cat. The internal carotid is always very small, and may not even be patent. The circle of Willis is supplied mainly by branches from the external carotids in the orbital fissure and from the vertebral arteries.

With the present injection technique the injected substance passes to extracranial as well as intracranial branches of the carotid artery. It is difficult to estimate the concentration of contrast medium in the cerebral vessels after injection into the common carotid; it probably varies considerably from one animal to another. Measured per kg body weight, 0.2 ml in a cat corresponds approximately to 4 ml in man.

The cerebral arteries are considered to be less sensitive to vasoactive substances than arteries in other vascular areas. SCHMIDT and HENDRIX (1937) showed that the injection of a potent vasodilator drug, *e. g.* histamine, into the common carotid artery in the cat, might bring about a redistribution of blood from the intracranial to extracranial vessels, thus simulating vasoconstriction in the brain. This effect is attributed to the greater sensitivity of the extracranial vessels to the dilator drug. The injection of a vasoconstrictor agent, *e. g.* adrenaline, may cause a redistribution in the other direction, simulating vasodilatation in the brain. Hence, the increased flow in the superior sagittal sinus after injection of sodium acetrizoate could possibly be a result of marked constriction of the extracranial vessels, with an increase in the blood flow to the brain. LINDGREN and TÖRNELL showed, however, that sodium acetrizoate had a strong vasodilator effect on arteries in the muscles and skin, which are the main tissues supplied by the external carotid artery; indeed, we assumed that the increase in flow that must have taken place in these regions following the injection of 0.2 to 0.4 ml sodium acetrizoate 50 %, amounted to 500 to 1 000 per cent. The increase that we observed in the cerebral blood flow after injection of sodium acetrizoate cannot therefore be explained as a redistribution effect. But such a mechanism may very well account for the many injections of sodium acetrizoate that had little or no effect on the outflow from the superior sagittal sinus. If there is such marked dilatation of the extracranial vessels, the pressure in the circle of Willis may decrease and the blood flow through the brain will then not increase with the relaxation of the cerebral vessels.

Another possible explanation of the negative observations is that in these cases only diluted contrast medium or none at all had reached the regions of the brain from which the venous outflow was recorded. According to INGVAR and SÖDERBERG (1956) the superior sagittal sinus drains principally the frontal and parietal parts of the cerebral cortex. A difference in the distribution of the injected substance from one experiment to another is indicated by the observation that injection into the carotid artery on one side did not produce the same response as a corresponding injection on the other. It is possible, too, that the cerebral region drained by the superior sagittal sinus is not bilaterally symmetrical.

LINDGREN and TÖRNELL reported that sodium diatrizoate had a distinct — though, compared with acetrizoate, rather weak — vasodilator effect during peripheral arteriography. The reason why this vasodilator action of sodium diatrizoate failed to appear in the present investigation, may be the relative insensitivity of the cerebral vessels — the effect of sodium acetrizoate was also definitely weaker than in peripheral arteriography. The above-mentioned problems as to the distribution of the injected media should also be borne in mind as a possible explanation.

This substantial increase in the cerebral blood flow during carotid angiography with sodium acetrizoate has not, to our knowledge, been demonstrated earlier. The problem has, however, been touched upon by GREITZ. Using an isotope technique, he measured the circulation time in the brain after intracarotid injection of 4 ml Triurol 50 % compared with 1 ml of physiologic saline. He found no difference, and commented: 'The contrast medium, however, does not have any obvious systematic influence on the circulation time through the brain.' He made the measurements in connection with the injection of the contrast medium. Had he made another measurement a minute or so later, he might have observed a shortening of the circulation time due to the increased flow; for there is a latency of 5 to 10 seconds from the moment of injection until the vessels dilate and the flow begins to increase. It is not certain, however, that changes in the circulation time and blood flow in the sagittal sinus are strictly parallel. (As regards the relationship between the circulation time and cerebral blood flow reference should be made to BROBEIL, HÄRTER, HERRMANN and NILSSON.)

The increased outflow from the superior sagittal sinus that follows injection of sodium acetrizoate into the carotid artery is, in our opinion, due to a direct effect of the contrast medium upon the intracranial vessels — a direct paralysis of the smooth muscle fibers in the walls of the small vessels.

As regards the clinical implications of these findings it has for instance been stated by BROADBRIDGE that sodium diatrizoate causes the patient much less discomfort during carotid angiography than does sodium acetrizoate. We do not know if the unpleasant sensations may be due to the vasodilator action of the contrast medium but such a relationship may exist.

The fact that a contrast medium has a considerable vasodilator effect does not necessarily mean that it is unsuitable for carotid angiography. In any case such a substance seems to be better than contrast media causing vasoconstriction and a decrease of flow, at least in patients with an impaired cerebral circulation. On the other hand, the vasodilator effect of the contrast medium may conceivably have a bearing on the occurrence of cerebrovascular complications after carotid angiography.

Acknowledgement

We wish to thank AB Leo, Hälsingborg, and AB Erco Pharmaceuticals, Stockholm, for placing generous supplies of Triurol and Hypaque at our disposal. This investigation was supported by a grant from the Swedish Medical Research Council to one of us (P. L.), which is gratefully acknowledged.

SUMMARY

The systemic blood pressure and blood flow in the superior sagittal sinus were recorded following the injection of Triurol (sodium acetrizoate) and Hypaque (sodium diatrizoate) into the common carotid artery in cats. The effect of the former varied but in typical cases the increase in the blood flow amounted to 100 to 300 per cent and lasted for 10 to 30 minutes. Corresponding amounts of Hypaque produced no changes in the blood flow. The difficulties associated with the present method for measuring cerebral blood flow are illustrated and discussed. The clinical implications of the observations are outlined.

ZUSAMMENFASSUNG

Der Systemblutdruck und die Durchblutungsgeschwindigkeit im Sinus sagittalis superior wurden bei Katzen nach Injektion von Triurol (Natriumazetrizoat) und Hypaque (Natriumdiatrizoat) in die Arteria carotis communis registriert. Die Wirkung des Triurols variierte, aber in typischen Fällen stieg die Strömungsgeschwindigkeit um 100 bis 300 % an und dauerte 10 bis 30 Minuten. Entsprechende Mengen Hypaque erzeugten keine derartigen Veränderungen. Die mit der gegenwärtigen Methode zur Messung der Hirndurchblutung verbundenen Schwierigkeiten werden illustriert und besprochen. Die klinische Bedeutung dieser Beobachtungen wird skizziert.

RÉSUMÉ

Les auteurs ont enregistré sur des chats la pression sanguine systémique et le débit sanguin dans le sinus longitudinal supérieur après injection de Triurol (acetrizoate de sodium) et d'Hypaque (diatrizoate de sodium) dans la carotide primitive. L'effet du Triurol a été variable, mais dans les cas typiques l'augmentation du débit sanguin a atteint 100 à 300 pour cent et a duré de 10 à 30 minutes. Des quantités correspondantes d'Hypaque n'ont pas modifié le débit sanguin. Les auteurs étudient et illustrent par des exemples les difficultés inhérentes à cette méthode de mesure du débit sanguin cérébral. Ils soulignent les conséquences cliniques de leurs observations.

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BLOOD PRESSURE AND HEART RATE RESPONSES IN CAROTID ANGIOGRAPHY WITH SODIUM ACETRIZOATE (TRIUROL)

An experimental study in cats

by

Percy Lindgren and *Gunnar Törnell*

In carotid angiography with sodium acetrizoate GREITZ (1956) has observed alterations in the blood pressure and heart rate in most of his material of human subjects (4 ml Triurol 50 %). These usually consisted in falls of short duration, the systolic pressure being reduced by a maximum of 10 per cent, with concomitant moderate brady-cardia and arrhythmia. In GREITZ' opinion, carotid sinus reflexes were unlikely to have been responsible for these reactions; the mechanism behind them appeared to be a direct influence of the contrast medium upon vasomotor active structures in the brain.

Transient hypotensive and bradycardic effects were noted by HEINRICH and KESSEL (1940) following the intracarotid injection of Thorotrast in dogs. Similar results were reported by WEATHERALL (1942) with Diodone and Iodoxyl in cats, BROMAN and OLSSON (1948) with various diodone contrast media in rabbits, SCHMIDT (1955) with Thorotrast, Perabrodil, Ioduron, Umbradil and Urografin in cats and rabbits, KLINGLER

et coll. (1956) with Ioduron and Diodone in man, dogs, cats, and rats, and PEDACHENKO (1957) with Cardiotrast in dogs and rabbits.

LINDGREN (1958) verified GREITZ' observations in experiments upon cats. On comparison of sodium acetrizoate (Triurol), sodium diatrizoate (Hypaque), and diprotrizoate (Miokon), moreover, the most conspicuous effects on the systemic circulation were found to attend angiography with acetrizoate.

The aim of the present investigation was to study experimentally the mechanism of these effects on the circulatory apparatus in carotid angiography. For this purpose we chose sodium acetrizoate (Triurol), the contrast medium that GREITZ employed and which, according to LINDGREN, has significant effects.

The fall of blood pressure in cerebral angiography may have various causes. Earlier authors have discussed an effect of the contrast substance on the baroceptors in the carotid sinus. Furthermore, a locally diminished peripheral resistance in the brain, due to a dilator effect on the cerebral vessels through a direct influence on their walls — several contrast media are known to have such vasodilator properties — may contribute to the fall in blood pressure. When the substance enters the general circulation, it may have a systemic action on the heart and vessels. An important consideration is that the contrast medium passes through the brain capillaries and may influence vasomotor active regions. Such regions are capable of producing a drop in the blood pressure, either through a vagus effect, or by inhibiting the sympathetic vasoconstrictor tone or activating sympathetic vasodilator nerves.

Methods

The series consists of 41 cats of weights ranging from 2.0 to 5.0 kg and averaging 2.7 kg. They were anesthetized with Dial (30 to 70 mg/kg; average 50 mg/kg).

The animals were prepared, on the whole, as described in a preceding paper by LINDGREN (1958). The neck dissection was somewhat more detailed, however; for not only were the carotid artery with its branches and the vagus nerve dissected free, but the sinus nerve from the carotid sinus to the junction with the glossopharyngeal nerve was similarly dealt with.

The Swedish sodium acetrizoate agent, Triurol, 50 %, was used in all experiments.

Results

General character of the responses (*blood pressure fall and bradycardia*). The principal cardiovascular reaction in carotid angiography with Triurol consisted in a fall of blood pressure and bradycardia. In some experiments, however, there were also other responses of a somewhat different character, namely, an initial rise of blood pressure that preceded the fall and,

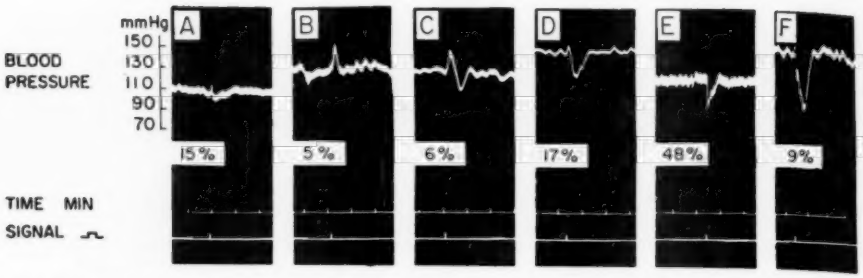

Fig. 1. Various types of blood-pressure responses (referable to different experiments), on injection of Triurol 50 % in a dose of 0.2 ml into the common carotid artery. The percentages are based on a classification of the entire series: 242 injections (0.05 to 0.5 ml) in 41 experiments.

A. Response (rise or fall) $<$ 10 mm Hg
B. Blood-pressure rise alone, $\geqq$ 10 mm Hg
C. Initial rise of blood pressure $\geqq$ 10 mm Hg (greater than or equal to the fall)
D. Initial rise less than the predominant fall (10 mm Hg $\leqq$ blood-pressure fall $\leqq$ 30 mm Hg)
E. Blood-pressure fall alone (10 mm Hg $\leqq$ blood-pressure fall $\leqq$ 30 mm Hg)
F. Blood-pressure fall with or without initial rise (fall $>$ 30 mm Hg)

less commonly, an elevation alone (as well as some cases that showed no response at all, though here it seems doubtful whether any contrast medium reached the pertinent structures in the brain (cf. the discussion in the paper of KÅGSTRÖM et coll. 1958).

Fig. 1 illustrates a few different types of responses as far as the blood pressure is concerned. These are grouped according to their main character: A, B, C, D, E and F. A fall of blood pressure with or without a slight initial rise was the commonest reaction, occurring in no less than 74 per cent of animals (groups D, E and F). Its magnitude varied a good deal from one animal to another; it usually amounted to about 15 to 30 mm Hg, but occasionally 40 to 60 mm Hg was recorded. The experiments in which a rise of blood pressure predominated were clearly in the minority, amounting to only 11 per cent (groups B and C). In one and the same experiment the responses invariably had the same character and could readily be reproduced. As a rule the lowest dose producing a distinct fall of pressure was 0.1 ml and in exceptional cases only 0.05 ml. The highest consistently administered dose was 0.4 ml; larger doses were often associated with local or generalized spasms and respiratory disturbances.

The response in the individual experiment was as a rule quantitatively dependent on the dose injected, a larger dose generally producing a somewhat greater fall in blood pressure (Fig. 7). We nevertheless failed in the series as a whole to correlate the type of response to the dose. For instance, the mean dose in group D was 0.25 ml, in group E 0.20 ml, and in group F 0.23 ml — differences which cannot be considered significant.

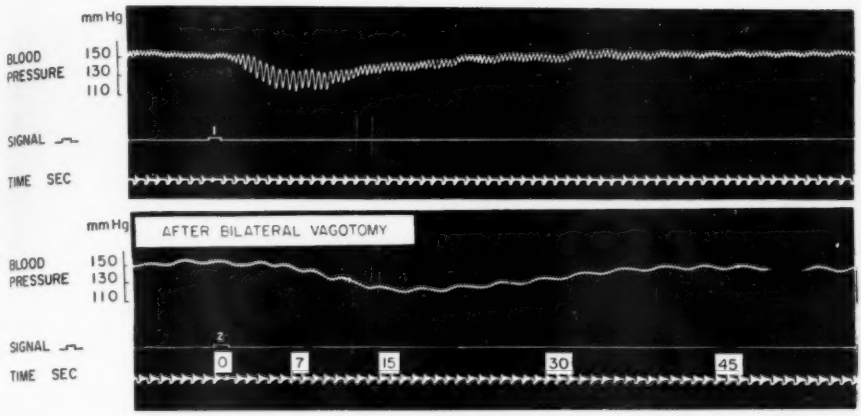

Fig. 2. Cat 2.5 kg. Dial 50 mg/kg.

Injection of 0.1 ml Triurol into common carotid artery before (1) (upper record) and (2) after bilateral vagotomy (lower record). The bradycardia is completely abolished by this procedure, but not the fall in blood pressure.

Time:	0 sec	3 sec	7 sec	15 sec	30 sec	45 sec	60 sec
1. Heart rate/min	195	125	105	155	170	185	195
Mean B. P. (mm Hg) ..	155	145	125	135	150	155	155
2. Heart rate/min	215	215	215	215	220	220	220
Mean B. P. (mm Hg) ..	155	155	150	125	130	145	150

The bradycardic component was studied only in some of the experiments. The results accorded, by and large, with those communicated in the paper by LINDGREN, *i. e.* a brief reduction of 20 to 30 per cent in the heart rate. A marked bradycardic response associated with a blood-pressure drop is illustrated in Fig. 2. It should be noted, however, that bradycardia seldom if ever attended such minimal blood-pressure responses that were assignable to group A. Similarly, no bradycardia was observed in responses of type B, *i. e.* clear-cut elevations of blood pressure, and only very slight bradycardia in a few cases in group C. Neither was there any strict parallelism between the bradycardia and blood-pressure fall in groups D, E, and F. Thus slight bradycardia (5 to 15 per cent), for instance, sometimes accompanied a substantial blood-pressure response of type F.

Latency. In order to duplicate clinical conditions the injections into the common carotid were performed rapidly, over the course of one or two seconds. As will be seen from the upper curve in Fig. 2, the latency preceding the response (from the start of the injection to the first pro-

longed pulse interval) amounted to two seconds. The response was most marked (lowest blood pressure and heart rate) after 6 to 8 seconds. It had more or less subsided after 15 seconds, and the heart rate and blood pressure had returned to normal in 30 seconds. Similar values were recorded in several experiments, with some variation in the duration, upwards or downwards, according to the magnitude of the dose.

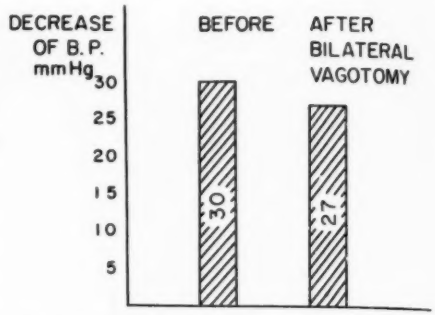

Diagram 1. Blood pressure before and after bilateral vagotomy. Mean values from 10 experiments. In each experiment the same dose, 0.1 to 0.4 ml Triurol 50 %, was given before and after the vagotomy. Before vagotomy there was an initial rise in 3 cases, after vagotomy in 5 cases.

It can already be concluded from the short latent period that nervous mechanisms mediate the response. The latter cannot be due to a local effect of the contrast medium on the heart, since after two seconds no contrast medium has had time to reach it. Backflow in the carotid during the injection itself is theoretically conceivable — contrast medium might thus reach the coronaries via the aorta — but not only does the injected volume seem too small for this, but identical results were found on temporary occlusion of the carotid artery proximal to the injection site.

Influence of vagal impulses. The result of the experiment illustrated in Fig. 2 shows that the bradycardia was produced via vagal impulses. With both vagus nerves intact, the animal had a heart rate of 195 per minute, but coincident with the maximum response it fell to 105 — a decrease of 47 per cent. After bilateral vagotomy the basal heart rate rose to 215 per minute. In the lower curve there is now no signs of a bradycardic effect on further injection of sodium acetrizoate in the same dose. The blood-pressure fall, on the other hand, was the same before and after bilateral vagotomy, *i. e.* 25 to 30 mm Hg. However, the latent period was prolonged from 2 to about 6 seconds and the maximum response (lowest blood pressure) moved from 6 to 8, to 17 to 20 seconds.

Mechanism of post-vagotomy blood pressure responses. It even seems plausible to attribute the type of blood-pressure fall that persisted after bilateral vagotomy to nervous activity initiated via an effect on the cerebral regions. True, we have found earlier (LINDGREN and TÖRNELL 1958) that Triurol has a marked peripheral vasodilator action, but the short latent period is unlikely to permit a reduction of the general periph-

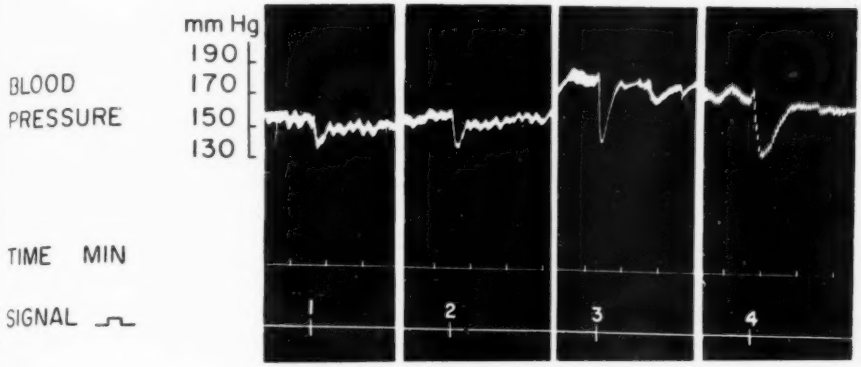

Fig. 3. Cat 2.2 kg. Dial 45 mg/kg.

Blood pressure responses to injection of Triurol 50 % into the right common carotid. 0.2 ml given in all four cases.

1. Normal conditions, blood pressure level 155 mm Hg, decrease 20 mm Hg
2. After section of right sinus nerve, blood pressure 160, decrease 20 mm Hg
3. After section of left sinus nerve as well, blood pressure 180, decrease 40 mm Hg
4. After bilateral vagotomy, blood pressure 170, decrease 35 mm Hg

eral resistance after distribution of the contrast medium into the systemic circulation. In point of fact the measured latency of 6 to 7 seconds is fully consistent with the findings of LINDGREN (1955), who observed that the latent period for a depression of the peripheral resistance by central activation of vasomotor nerves had that order of magnitude.

Similar observations on the disappearance of the bradycardic component but persistence of the blood-pressure fall after bilateral vagotomy were made in ten experiments. The results of these are condensed in Diagram 1. It was found, moreover, that 0.5 mg atropine per kg body weight intravenously had the same effect as bilateral vagotomy. Yet in these cases too, the blood-pressure fall remained; hence it can also be assumed that this was not due to activation of sympathetic vasodilator nerves (their activity is completely blocked by that dose of atropine, *vide e. g.* LINDGREN 1955). It accordingly seems plausible to interpret this component of the response as an inhibition of the sympathetic vasoconstrictor tone.

Significance of carotid sinus reflexes. The intracarotid injections were given proximal to the carotid sinus, and they might conceivably affect, both mechanically and chemically, receptors in that region. According to GREITZ (1956), however, carotid angiography injections do not alter the

intracarotid pressure in man. We did not study the corresponding behavior in cats, but conducted a series of experiments in which the blood-pressure responses were studied before and after denervation of the carotid sinus. The sinus regions were carefully dissected free bilaterally. The sinus nerve was identified according to four principles: (1) determination of the anatomic position, (2) electrical stimulation producing typical major falls of blood pressure, (3) section resulting in elevation of the blood-pressure level, and (4) occlusion of the carotids with no blood-pressure response after section.

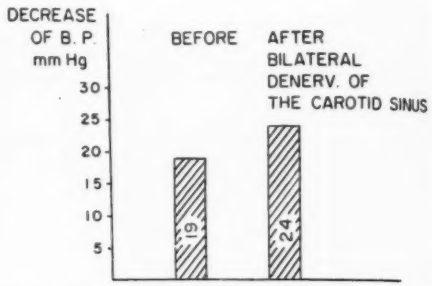

Diagram 2. Blood pressure responses before and after bilateral denervation of carotid sinus. Mean values from 7 experiments. In each experiment the same dose, 0.1 to 0.4 ml Triurol was given before and after denervation. In 2 cases there was an initial rise both before and after denervation.

A typical experiment of this kind is illustrated in Fig. 3. In the intact animal, injection of 0.2 ml sodium acetrizoate into the right carotid produced a blood-pressure fall of 20 mm Hg. A similar injection repeated after section of the right sinus nerve gave the same response. After bilateral sinus denervation the blood-pressure level rose from 150 to 180 mm Hg. In this case (No. 3 in the figure) there was a heightened response, the blood pressure falling by no less than 40 mm Hg, which finding should be viewed in the light of both the higher sympathetic tone and the elimination of the buffering capacity of the sinus mechanism. Bilateral vagotomy was then performed; the only change in response (No. 4 in the figure) lay in delayed return of the blood pressure to normal, possibly because the aortic arch mechanism was now also out of action. Similar results were recorded in seven experiments, suggesting that carotid sinus reflexes were not of prime significance in the blood-pressure responses. The fall of blood pressure, as is evident from Diagram 2, was also on the average more marked after carotid sinus denervation.

The bradycardic component was also found to be independent of the carotid sinus (Fig. 4). In this experiment 0.2 ml Triurol gave rise to marked bradycardia. The response was not appreciably altered after bilateral section of the sinus nerves. The result thus corroborates the assumption that the vagal bradycardia was initiated by the effect of the contrast medium on vagus-facilitating centers in the brain.

Cerebral or extracerebral point of attack. With the mode of administration employed here, the contrast medium was distributed both to the

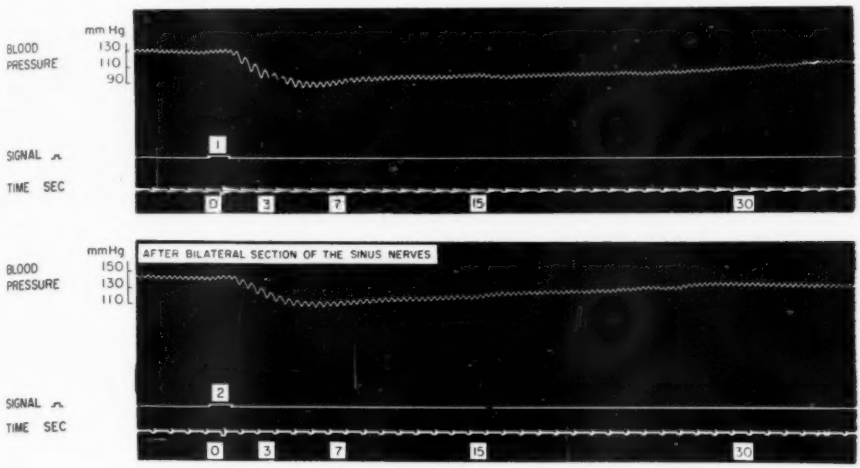

Fig. 4. Cat 2.6 kg. Dial 65 mg/kg

The bradycardia (and fall of blood pressure) persists after sectioning of both sinus nerves. The responses were elicited by 0.2 ml Triurol 50 % injected into the right common carotid.

Time:	0 sec	3 sec	7 sec	15 sec	30 sec
1. Heart rate/min	215	115	175	210	225
Mean B. P. (mm Hg)	130	110	90	100	110
2. Heart rate/min	195	115	155	185	200
Mean B. P. (mm Hg)	145	125	110	120	135

brain and to the majority of extracerebral tissues in the skull. It is known that sodium acetrizoate in carotid angiography may produce various sensations, such as heat, formication and pain, if it is distributed to the face. These sensations are probably mediated by the trigeminal nerve.

We sought in two ways to ascertain if such trigeminal impulses constituted the afferent pathway in a reflex arc, with vagal activity and sympathetic inhibition as efferent pathways. First, we severed the trigeminal nerve in two cases, on the same side as the injection, intracranially proximal to the Gasserian ganglion — a rather complicated and time-consuming operation. The results showed that the blood-pressure responses were unaffected by this measure. Secondly, we tried to increase the amount of contrast medium to the brain while retaining or reducing the extracerebral amount, on the working hypothesis that if the point of attack was cerebral, the responses should be heightened. Most cats, unfortunately, have an insignificant internal carotid artery, and, according to DAVIS and STORY (1943), that artery is as a rule obliterated. These investigators found it patent in only one case in eleven. However,

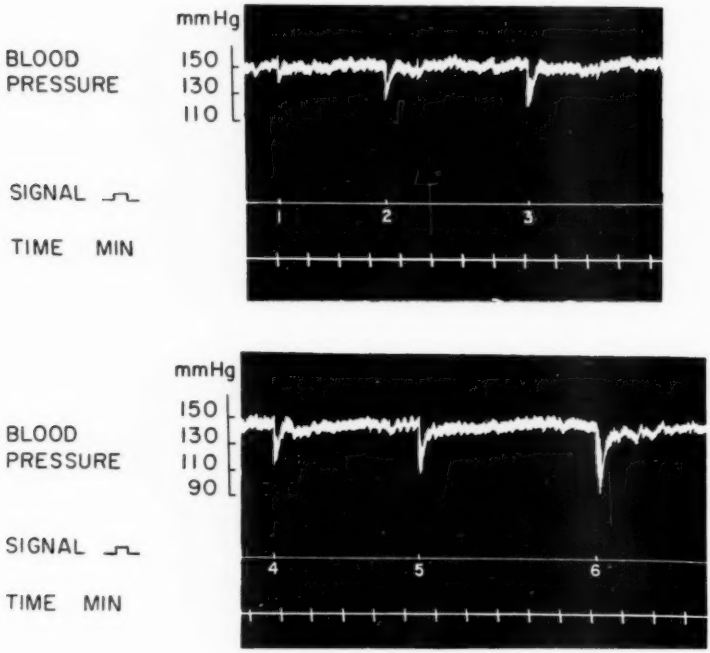

Fig. 5. Cat 2.5 kg. Dial 50 mg/kg.

Blood pressure responses to injection of Triurol 50 % into right common carotid. (For explanation see text.)

1. 0.05 ml Decrease of blood pressure 10 mm Hg
2. 0.1 » » » » » 20 » »
3. 0.2 » » » » » 25 » »

Beween (3) and (4) the external carotid artery was ligated so that the major part of the contrast medium passed through the internal carotid artery.

4. 0.05 ml Decrease of blood pressure 25 mm Hg
5. 0.1 » » » » » 35 » »
6. 0.2 » » » » » 45 » »

there is often an anastomosis between the ascending pharyngeal artery, which has its origin contiguous to the internal carotid artery, and the circle of Willis, wherefore a far greater proportion of cats probably have a functioning 'internal carotid', but the brain receives its main arterial supply via the carotid plexus, belonging to the external carotid system, and via the vertebral artery. By selecting cats with a relatively large internal carotid and a large ascending pharyngeal artery we were nevertheless able, in several cases, to carry out the simple type of experiment

that is illustrated in Fig. 5. In Nos. 1, 2 and 3 in the figure we injected increasing doses of Triurol: 0.05, 0.1 and 0.2 ml, respectively. A similar series of injections was repeated after occlusion of the external carotid artery. This measure served to increase the blood-pressure responses considerably — from 10, 20 and 25 mm Hg before, to approximately 25, 35 and 45 mm Hg, respectively, after the occlusion. It seems reasonable to assume that this cat had had a well-functioning internal carotid artery, and that in this way a greater amount of contrast medium was distributed to the brain after occlusion of the external carotid artery. There is, accordingly, cogent evidence of a direct cerebral point of attack of the contrast medium.

Local vasodilatation in the head as a possible contributory cause of the blood-pressure fall. Sodium acetrizoate, as pointed out in the introduction, has a powerful vasodilator action, even on cerebral vessels, when injected intra-arterially. After injection of small amounts of Triurol 50 % into the femoral artery, the blood flow in the leg increases by several hundreds per cent; this locally reduced peripheral resistance is reflected in a very slight temporary fall of blood pressure (0 to 10 mm Hg) as mentioned in a previous paper (LINDGREN and TÖRNELL 1958). On carotid angiography in cats KÅGSTRÖM et coll. 1958 observed an increase of the blood flow in the superior sagittal sinus, in several cases of two hundred per cent.

With a view to studying the role of this factor as a possible contributory cause of the blood-pressure fall associated with carotid angiography, the following type of experiment was performed. After observation of the usual response to injection of Triurol into the common carotid artery (blood-pressure fall of 20 to 30 mm Hg), the spinal medulla was divided at the level of the first cervical vertebra and bilateral vagotomy performed. In order to maintain a 'normal' blood pressure, noradrenaline solution was given in continuous infusion and in addition, artificial respiration was applied. All efferent nervous communications between the brain and the cardiovascular system were accordingly severed. The insignificant blood-pressure fall (5 to 10 mm Hg) that accompanied further injection of the contrast agent suggested that the drop was normally due principally to nervous factors and that a reduction of the peripheral resistance in the region of distribution of the carotid did not appreciably affect the systemic blood pressure.

Discussion

The observation that intracarotid injections of contrast medium generally produce transient hypotension and bradycardia, both in man and in various laboratory animals, has been made by numerous investi-

gators (for more detailed references, *vide* GREITZ 1956). Yet very few of them have attempted to elucidate or even discuss the mechanism of these effects.

The responses observed here during carotid angiography in cats are probably of the same nature as those described by GREITZ in human subjects. Thus the latent period for the bradycardic component, for instance, was of the same order of magnitude. GREITZ reported that the maximum response occurred 1 to 6 seconds after conclusion of the injection (*i. e.* 2 to 7 seconds after its start). In the present investigation the latent period was measured at about 2 seconds (with intact vagal function), and the maximum response was found after 3 to 8 seconds. Where the fall of blood pressure was not preceded by a rise, its initial phase may well have been caused by the bradycardia, which possibly gave rise to a temporary reduction of the cardiac output. In vagotomized animals the blood-pressure fall occurred after a longer latency (6 to 8 seconds). In these cases it is likely to have been due not to a cardiac effect but to a general depression of the peripheral resistance, probably resulting from central inhibition of vasoconstrictor tone.

FOLTZ et coll. (1952), on intracarotid injection of Diodrast in cats and monkeys as well as human subjects, observed a blood-pressure fall and bradycardia, the latter of which they regarded as 'vagal slowing'. However, they presented no direct evidence of the vagal origin of this bradycardia. As regards the point of attack, it is interesting to observe that they considered a direct cerebral one to be probable, for they found that in those cases where no electrocardiographic changes occurred the injection had been given below the carotid bifurcation, whereas 'all injections through a catheter threaded up to the base of the skull resulted in some type of electrocardiographic or pulse rate abnormalities, presumably due to the higher concentration of Diodrast reaching the brain'. GREITZ placed a similar interpretation upon his own analogous observations of blood-pressure fall and bradycardia. The results of our studies tend to confirm these suppositions.

The role of sinus reflexes in the mechanism of origin of circulatory phenomena in angiocardiography was discussed by ROBB and STEINBERG (1939), who observed a fall of blood pressure and cardiac acceleration (regularly), or a fall of blood pressure and momentary bradycardia (occasionally). In four cases they noted responses to intravenous Diodrast 70 % before and after the block of both carotid sinuses; in two cases Diodrast 35 % was injected directly into the common carotid to investigate its action upon the carotid sinus, the diencephalic centers and the cerebral cortex. ROBB and STEINBERG concluded that 'the carotid sinus is not a factor in the causation of the hypotension and plays little or no part in the tachycardia; it is responsible, however, for the transient bradycardia.

There is no evidence to suggest that the cardiovascular response is caused by direct stimulation of the diencephalic centers or the cerebral cortex'. As regards the bradycardia, these conclusions do not seem to be consistent with our own findings but it is difficult to draw parallels, for these workers gave intravenous injections of mainly large amounts of the contrast medium (and here the medium may be expected to produce direct peripheral effects); only in two cases were intracarotid injections performed, and in neither do the reported data permit a detailed discussion.

Our hypothesis as to the minor significance of sinus reflexes is also held by BROWN and STERN (1954), who wrote: 'No evidence was obtained to support the hypothesis that the carotid sinus may be sensitive to iodopyracet'. They drew their conclusions from experiments in cats, in which iodopyracet (Diodrast) was injected into the carotid artery before and after local anesthesia of the carotid sinus region.

With regard to sodium acetrizoate the hypotension and bradycardia that attend intracarotid injection are, according to our results, due to a direct effect on cerebral structures, the carotid sinus mechanism having no primary significance. It by no means follows, however, that the latter mechanism has no quantitative bearing on the responses, for, with the fall of blood pressure, secondary compensatory reactions may then be produced. Comparison of the blood-pressure responses before and after section of the sinus nerve suggests that such a buffering action does in fact occur. It may be pointed out, parenthetically, that in clinical carotid angiography the mechanical manipulations with the injection cannula may possibly give rise to sinus reflexes (TURNBULL 1939, GREEN and ARANA 1948, JOHANSSON 1954).

As to the region of the brain from whence the responses are elicited, the possible role of the hypothalamus has been discussed by several authors, including BROWN (1955). The latter observed that patients with subarachnoid hemorrhage exhibited a greater fall in blood pressure than others during carotid angiography (8 to 10 ml Uriodone 35 %). The cause in his opinion was that the vessels in the hypothalamus were hypersensitive following the trauma and that nervous disturbances arose more easily (possibly as a result of vasospasm).

Our investigation also provides no definite answer to this question. In this connection special interest attaches to the intracerebral distribution of the carotid blood. According to HOLMES et coll. (1958) who investigated the distribution of the carotid and vertebral blood in cats, the upper part of the brain stem and the hemispheres are normally supplied by the external artery, and possibly by the internal carotid artery if it exists. It is therefore plausible to suggest the hypothalamus as a likely region. Numerous autonomic functions are represented in this region from

which an abundant system of efferent autonomic pathways pass to the medulla oblongata and spinal medulla (*vide* LINDGREN 1955).

A problem sometimes discussed in such contexts as this relates to the hypertonicity of the contrast solutions. That this can be responsible for the responses observed has been advanced by *e. g.* PAGE et coll. in 1948, who in cats noted an initial rise in blood pressure followed by a moderate fall after intracarotid injection of 1 ml Diodone 50 %. COTRIM (1954) and ZSEBÖK et coll. (1954) propounded a similar hypothesis regarding the mechanism of the cardiovascular responses observed during angiocardiography.

BROMAN and OLSSON (1948), on the other hand, did not attribute the permeability disturbances which they observed to the hypertonicity of the solutions but regarded them as an effect of the contrast medium per se.

Conclusions

The blood pressure and heart rate were recorded during angiography of the carotid artery in a material of 41 cats. The injections (0.05 to 0.4 ml) of the contrast medium sodium acetrizoate (3-acetylamino 2, 4, 6-triiodobenzoate), or Triurol, were made into the common carotid artery or, in some cases, into the internal carotid artery.

The decrease in blood pressure was 10 to 50 mm Hg and the reduction in the heart rate was 20 to 40 per cent. In some cases there was a slight and transient initial rise in blood pressure. The latency of the responses was 2 to 3 seconds and, as a rule, they lasted less than one minute.

The circulatory responses seem to be elicited via an effect of the contrast medium on vasomotor structures in the brain. It is evident that the bradycardia is due to vagal impulses but only the initial phase of the decrease in blood pressure is caused by the bradycardia. The major cause seems to be a reduction of the sympathetic vasoconstrictor tone.

Acknowledgement

The expenses of this investigation were defrayed partly by a grant from Karolinska Institutet (G. T.) and partly by a grant from the Medical Research Council (P. L.). The Triurol used was kindly placed at our disposal by AB Leo, Hälsingborg.

SUMMARY

The effects of angiography by means of Triurol 50 % (sodium acetrizoate) injected into the carotid artery in a material of 41 cats, as shown by the lowering and slowing of the blood pressure and heart rate, respectively, are discussed. The conclusion is reached that the changes appear to be caused by the action of the contrast medium upon vasomotor structures in the brain. The significance of the bradycardia upon the blood pressure is considered.

ZUSAMMENFASSUNG

Der Effekt einer Angiographie, bei der Natriumazetrizoat (Triurol 50 %) in 41 Katzen in die Arteria carotis injiziert wurde, und der durch Herabsetzung und Verlangsamung des Blutdruckes bezw. der Herztätigkeit auftritt, wird besprochen. Man kommt zu der Schlussfolgerung, dass die Veränderungen durch die Einwirkung des Kontrastmittels auf vasomotorische Strukturen des Gehirns verursacht zu sein scheinen. Die Signifikanz der Bradykardie auf den Blutdruck wird erwähnt.

RÉSUMÉ

Les auteurs étudient sur 41 chats les effets de l'angiographie par l'acétrizoate de sodium (Triurol50 %) injecté dans l'artère carotide d'après la baisse de la tension artérielle et le ralentissement du coeur qu'elle provoque. Ils arrivent à la conclusion que ces modifications paraissent dues à l'action du moyen de contraste sur des structures vasomotrices situées dans le cerveau. Ils examinent l'influence de la bradycardie sur la tension artérielle.

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ROENTGEN EXAMINATION OF INTRACRANIAL MENINGIOMAS

by

Ingmar Wickbom and *Sture Stattin*

The meningiomas constitute the most important group of benign intracranial tumours which can be radically removed. According to several authors 15 to 20 % of intracranial tumours are meningiomas. The indications for surgery are greater in meningiomas than in gliomas and other intracerebral tumours, the latter being possible to remove only to a limited extent. An attempt to extirpate a glioblastoma is generally considered useless and in many centres not even craniotomy is performed if the diagnosis of a glioblastoma is regarded as certain. The possibility of differentiating preoperatively between meningiomas and intracerebral tumours, especially the malignant ones, is thus of great importance. The clinical signs, it is true, may in many cases indicate the true nature of the lesion but a definite diagnosis can as a rule not be made from these alone. Fortunately, more or less typical changes may in a high percentage be demonstrated roentgenologically. The various changes characteristic of meningiomas encountered in conventional roentgenography, cerebral angiography and encephalography as well as the frequency in which they occur have been discussed by several authors.

In order to obtain some idea as to how often it may be possible to determine the true nature of a tumour preoperatively by combining the results of the three methods mentioned, we have reviewed all cases of

intracranial meningiomas examined in our department from September 1951 to February 1957. The material, which consists of 80 cases of verified intracranial meningiomas, has been divided into 8 groups according to the Table below.

Table

Localization	Conventional roentgen	Angiography			Angiography		Pneumography		Total material	Tumour pathology determined
		Internal carotid	External carotid	Vertebral	Performed	Tumour pathology	Performed	Tumour pathology		
Parasagittal ...	7+2 (3)	7+5 (2)	8+3 (3)	—	18	11+3 (5)	10	0+1 (0)	18	14+3
Falx	0+2 (0)	2+1 (1)	1+0 (1)	—	6	2+1 (1)	2	0+0 (0)	6	2+0
Convexity	13+2 (1)	10+5 (1)	15+0 (1)	—	19	15+1 (6)	8	0+0 (0)	19	16+2
Sphenoidal ridge	5+1 (1)	4+2 (2)	5+0 (0)	—	8	7+1 (3)	6	0+3 (0)	9	8+1
Subfrontal	3+1 (0)	7+0 (3)	1+0 (0)	—	8	8+0 (3)	4	3+0 (0)	8	8+0
Suprasellar	1+2 (0)	2+0 (0)	0+0 (0)	—	4	2+0 (0)	5	3+1 (2)	5	4+1
Posterior fossa	2+2 (0)	3+1 (0)	1+0 (1)	3+5 (2)	12	5+4 (3)	12	4+2 (2)	14	7+4
Intraventricular	0+0 (0)	1+0 (0)	0+0 (0)	—	1	1+0 (1)	1	0+1 (0)	1	1+0
Total	31+12 (5)	35+14 (9)	31+3 (6)	3+5 (2)	76	51+10 (22)	48	10+8 (4)	80	60+11

The first figure in each column indicates the number of cases in which typical changes were found, and the second figure cases in which the changes were indefinite. Figures within brackets (in italics) indicate cases in which that examination alone permitted the correct diagnosis to be made.

A conventional roentgen examination was carried out in every case. Carotid angiography was performed in almost every case of supratentorial tumours. As a rule the internal and the external carotid arteries were injected separately but in a number of cases where direct puncture of the external carotid failed the injection was made into both arteries; in some cases only the common or the internal carotid artery was punctured. Vertebral angiography was performed in 11 out of the 14 cases of posterior fossa meningiomas. Encephalography was used in practically every case in which the tumour was situated in the posterior fossa or the suprasellar or subfrontal regions.

Conventional roentgenography

Changes in the structure of the bone are shown in Fig. 1. The worm-eaten appearance is caused by the tumour growing along the tiny vessels which penetrate the vault and sclerosis of the bone between these chan-

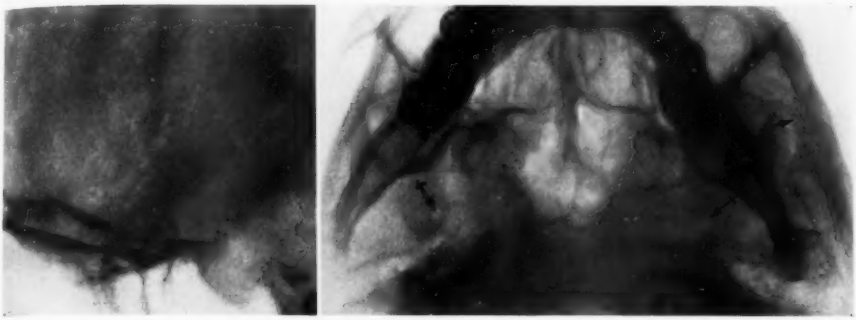


Fig. 1. Pterion meningioma on left side. Typical worm-eaten structure and thickening of bone (→). Left foramen spinosum enlarged (↔). Dorsum sellae partly destroyed by increased intracranial pressure.

nels. If the tumour extends to the outside of the vault, perpendicular striations, so called spiculae, may be seen (Fig. 2a); wide and tortuous vascular grooves in many cases run to and from this area. If the grooves for the meningeal arteries are widened and run a tortuous course this is in itself almost certain evidence of a meningioma (Fig. 2 b). Angiomatous malformations may also cause a widening of these grooves, it is true, but the differential diagnosis may easily be made by angiography.

In many cases reaction in the form of sclerosis occurs where the meningioma is attached to the bone. Local sclerosis in the vault is in itself

a b

Fig. 2. a) Parasagittal meningioma with typical spiculae. b) Convexity meningioma. The groove for the anterior branch of the medial meningeal artery is wide and tortuous. (The patient had no symptoms from the tumour, the examination being performed because of head injury.)

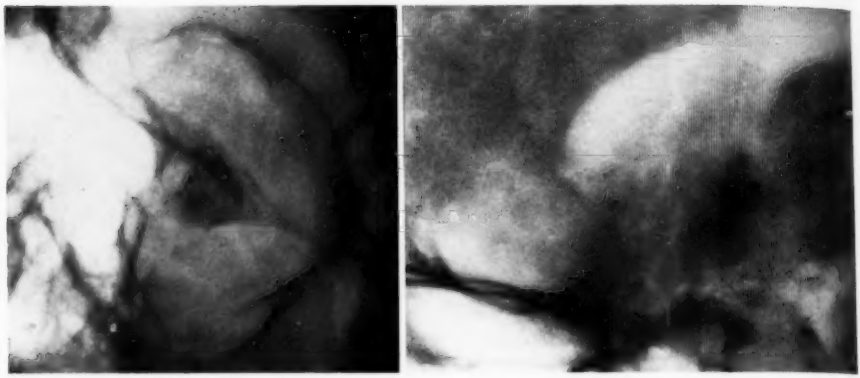


Fig. 3. Anterior clinoid process on left side thickened and sclerotic. No definite changes could be seen either at pneumography or angiography. At operation a meningioma was found 'carpeting' the anterior clinoid process. The left optic nerve was elevated and stretched by the tumour.

not necessarily of pathologic significance. If it corresponds, however, to a space-occupying lesion, as demonstrated by angiography or pneumography, it has been believed to be certain evidence of a meningioma. Local sclerosis in the greater or lesser wing of the sphenoid is of greater significance and may be considered diagnostic even if only little or no

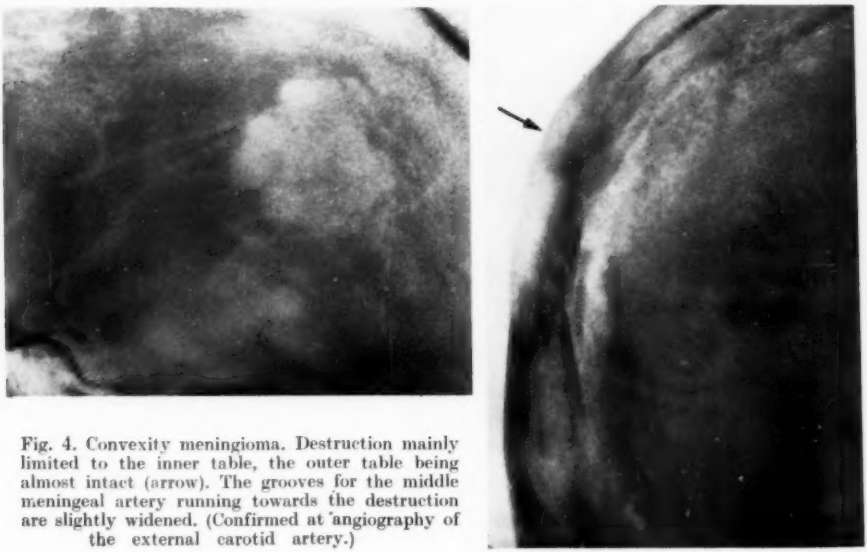


Fig. 4. Convexity meningioma. Destruction mainly limited to the inner table, the outer table being almost intact (arrow). The grooves for the middle meningeal artery running towards the destruction are slightly widened. (Confirmed at angiography of the external carotid artery.)

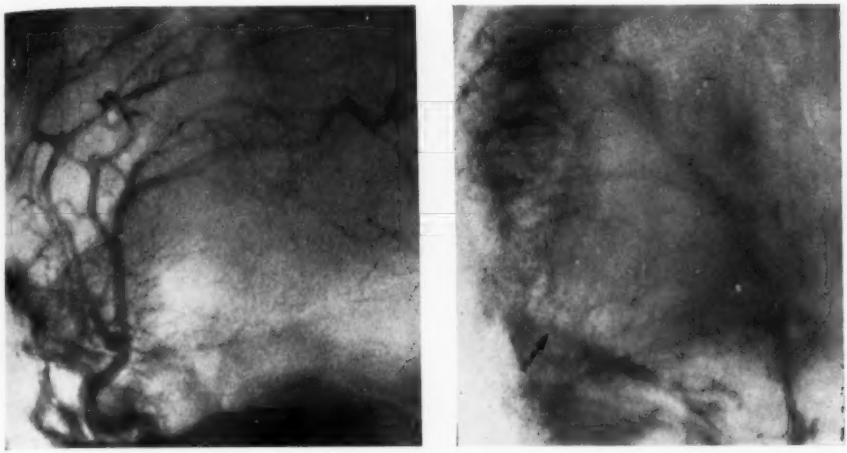
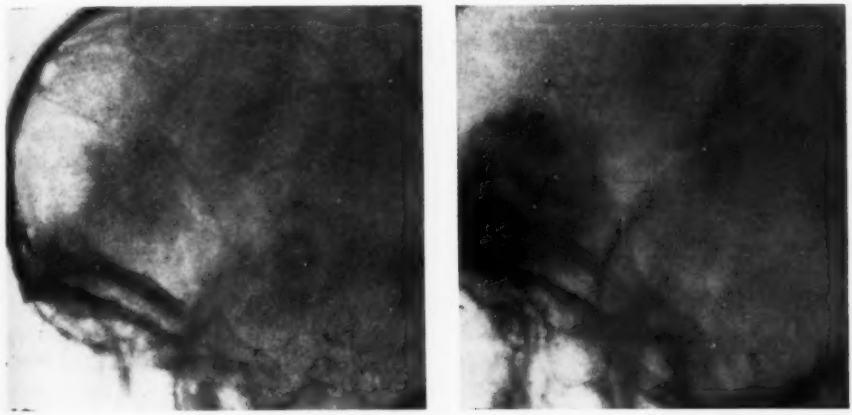


Fig. 5. Spherical pterion meningioma. Numerous small tortuous vessels penetrate the tumour in a broom-like fashion from the attachment at the pterion (arrow). Sylvian vessels displaced in an even arch around the tumour.

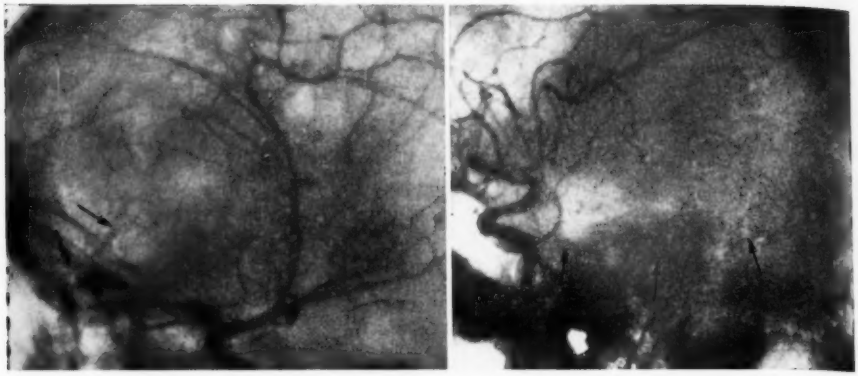


a b

Fig. 6. a) Frontal meningioma arising partly from the orbital roof. Angiography of internal carotid artery. Faint 'blush' seen in the capillary phase. b) Angiography of the external carotid artery. Marked blush already in arterial phase.

intracranial extension can be demonstrated at angiography or pneumcgraphy (Fig. 3).

Pure osteolytic changes are unusual in meningiomas and may be difficult to differentiate from other osteolytic processes such as eosinophilic granulomas, myelomas, tumour metastasis, xanthomatosis, etc.



a b

Fig. 7. a) Olfactory groove meningioma. Anterior cerebral artery displaced in a regular arch along the surface of the tumour. Vascular supply mainly from the hypertrophic anterior meningeal vessel, which branches from the ophthalmic artery (arrow). b) Meningioma from the tentorium. Vascular supply from an artery (probably the primitive trigeminal artery) arising from the carotid siphon before penetrating the outer dura (arrow).

If the destruction is localized mainly to the inner table of the vault, however, it is most certainly caused by a meningioma (Fig. 4).

Calcifications were seen in only 5 cases of our material. In most cases their appearance is not typical of meningioma. Tightly packed granular calcifications are, however, according to LINDGREN and DI CHIRO typical of suprasellar meningiomas and may be present also in posterior fossa meningiomas. Calcifications of this type, demonstrated in two of our cases, have been regarded as diagnostic.

Angiography

Tumour vessels with a tortuous course and a regular lumen without local dilatations or constrictions are typical of meningiomas. The vessels should be regularly arranged and penetrate the tumour in a broom-like fashion from its attachment (Fig. 5), or like spokes in a wheel from an artery running along the surface of the tumour. A blush or filling of the tumour has also in most cases been considered diagnostic (Fig. 6). A more or less homogenous blush may also be seen in some cases of glioblastoma or tumour metastasis. It does not, however, then have the same regular appearance as in meningiomas, and small irregular vessels are usually evident in the arterial phase. Tumour vessels of somewhat atypical appearances were found in some cases and registered as uncertain evidence of meningioma.

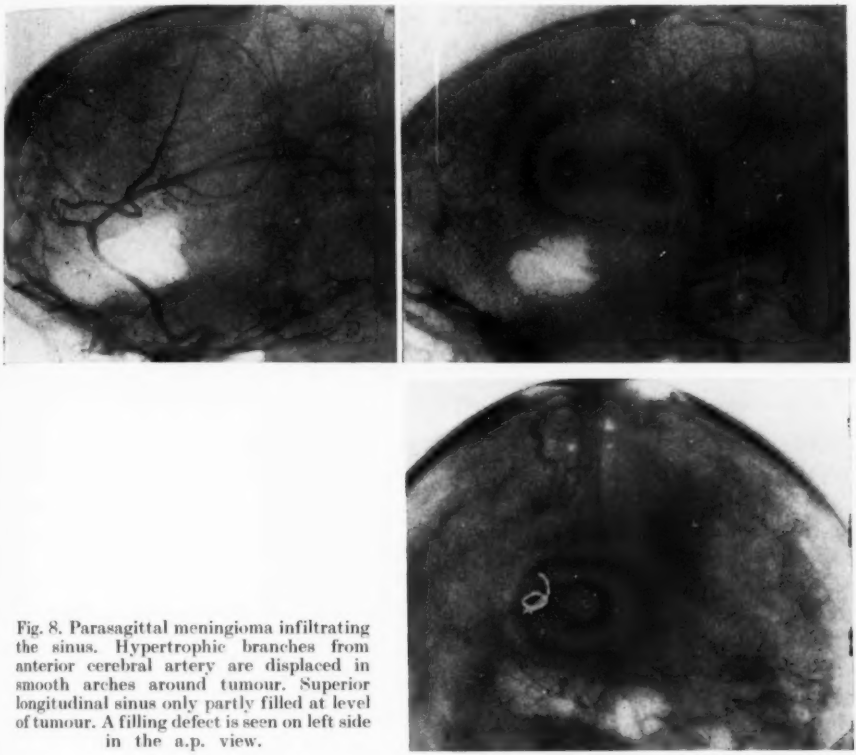


Fig. 8. Parasagittal meningioma infiltrating the sinus. Hypertrophic branches from anterior cerebral artery are displaced in smooth arches around tumour. Superior longitudinal sinus only partly filled at level of tumour. A filling defect is seen on left side in the a.p. view.

GREITZ has estimated the circulation time in tumours of different types by means of rapid serial angiography and found that this time is as a rule longer in meningiomas than in other vascular tumours, such as glioblastomas and metastases. Other authors (TÖNNIS et coll., inter alios), have come to the same conclusion. We have been using rapid serial angiography as described by GREITZ in most cases examined during the last two years. In the material presented in this article, however, estimation of the circulation time did not obviously contribute to a correct type diagnosis; in fact, dilated draining veins were in some cases filled even earlier than in the normal brain.

If a blood supply from the external carotid artery can be demonstrated this is the most certain way of diagnosing a meningioma. The best method of doing this is to inject the contrast medium directly into the external carotid artery. If the injection is performed into the common carotid

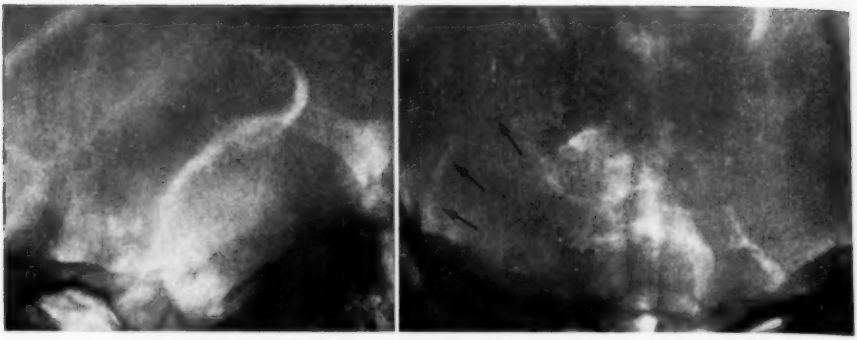
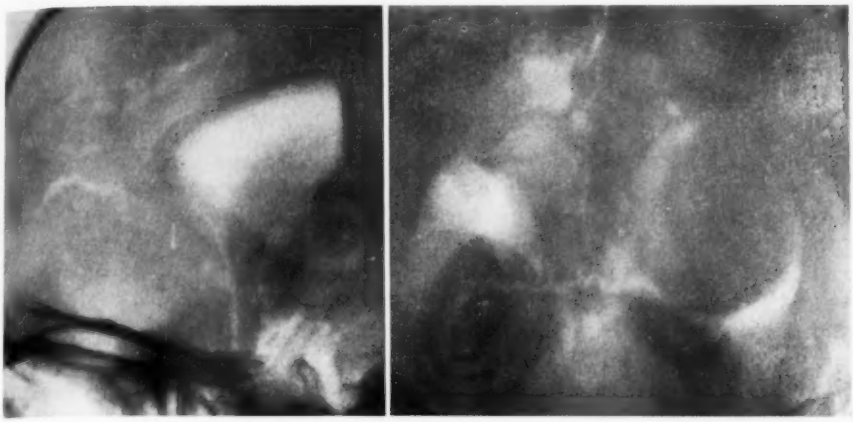


Fig. 9. Tentorium meningioma on right side surrounded by cisternal gas.

artery the filling of the small vessels is often less satisfactory and it may be difficult to find out for certain whether the tumour vessels are filled from the external or from the internal carotid artery. Meningiomas may sometimes be supplied by meningeal vessels arising from the internal carotid. Thus meningiomas from the olfactory groove are often supplied by the anterior meningeal artery which vessel arises from the ophthalmic artery (Fig. 7 a). Two of our meningiomas from the tentorium were supplied by an artery arising from the internal carotid artery before this vessel penetrated the outer dura (Fig. 7b). To our knowledge this possibility has not been pointed out before.

Parasagittal meningiomas often infiltrate the superior longitudinal sinus. If the contrast-filling of this sinus ceases abruptly at the level of the tumour the diagnosis of a meningioma infiltrating the sinus may be made (Fig. 8). In many of our cases, however, the contrast-filling of the sinus was not sufficient for definite conclusions to be drawn because of the small amount of medium used; the finding was accordingly registered as uncertain. The displacement of the vessels has often a somewhat different appearance if caused by a meningioma than when produced by an intracerebral tumour with its more infiltrating manner of growth. In meningiomas the arteries are as a rule displaced in arches around the tumour sometimes forming, as it were, a bowl in which the tumour appears to lie (Fig. 8). The arteries surrounding the tumour are often somewhat hypertrophic even if no real tumour vessels can be demonstrated (Figs. 5 and 7). Gliomas, on the other hand, usually infiltrate between the vessels and stretch them. Occasionally, however, a similar arrangement as to that usual in meningiomas may be seen in intracerebral tumours if they are well defined. This sign has therefore, unless very marked, been registered as uncertain.



a b

Fig. 10. a) Olfactory groove meningioma, partly outlined by gas. b) Intraventricular meningioma in the trigone of left ventricle. (The tumour was supplied by the hypertrophic anterior choroidal artery.)

Pneumography

An examination of the subarachnoid space is of the utmost importance for determining the true nature of the lesion. If the tumour can be shown more or less completely outlined by gas in the subarachnoid space this means that it is extracerebral (Figs. 9 and 10a). Extracerebral tumours are, with the exception of acoustic and pituitary tumours, practically always meningiomas. (Extracerebral tumours of other types such as cholesteatomas and neurinomas not located in the pontine angle are rare and may in this connection be disregarded.) Pituitary tumours, however, may be distinguished from purely suprasellar tumours by the appearance of the diaphragmatic cistern which is elevated by the former and depressed by the latter. Tumours which have been shown to be extracerebral have, therefore, with the exception of pituitary and pontine angle tumours, been regarded by us as meningiomas.

The displacement and the deformation of the ventricular system is to some extent different in extra- and intracerebral tumours. Irregular indentations in some part of the ventricular system indicate the presence of an intracerebral lesion. As pointed out by LINDGREN it is also sometimes possible to conclude from the appearances of the ventricles, especially of the temporal horn, that the tumour is deeply situated. Practically never however, is one able to decide from the appearances of the

ventricular system that a tumour is extracerebral. Intraventricular location of a tumour may as a rule be easily demonstrated by pneumography. If highly vascular, these tumours are usually supplied by the anterior choroidal artery (Fig. 10 b).

It is evident from the table shown earlier that it should be possible in most cases to make a correct preoperative diagnosis of meningiomas by combining the results of the three methods. This is true especially in meningiomas arising from the convexity of the skull, from the olfactory groove, and from the sphenoidal ridge. The chances are less good in posterior fossa tumours and parasagittal meningiomas, especially those arising from the falx. It may be that a more complete examination of the longitudinal sinus and the cistern above the corpus callosum could improve the diagnostic possibilities in the latter group. Angiography is the method which has mainly contributed to the result.

Typical changes are, however, seen in a high percentage of conventional examinations and an air-study is of great value for determining the true nature of the lesion, especially in cases of basal and posterior fossa tumours. In some few cases in our material the appearances either at angiography or pneumography seemed normal and the presence of a tumour could be demonstrated only by means of the other contrast method. It should be mentioned that other tumours sometimes produce angiographic appearances similar to those encountered in meningiomas. In some 15 cases of other tumours, mainly glioblastomas and tumour metastases, the suggestion of a meningioma has been made in the preoperative report. The tumours have in these cases been fairly well defined and tumour vessels of atypical appearance or signs of a more or less complete blush were seen in many of them. It may be that further experience and a more extensive use of rapid serial angiography for studying the circulation time according to GREITZ would make a correct diagnosis possible in some of these cases as well.

SUMMARY

The examination of intracranial meningiomas by means of conventional roentgenography, angiography, and pneumography is considered with special reference to a material of 80 verified cases. The typical appearances and the differential diagnosis from intracerebral tumours are described and discussed.

ZUSAMMENFASSUNG

Die Untersuchung intrakranieller Meningeome mit Hilfe der konventionellen Röntgenuntersuchung, der Angiographie und der Pneumographie wird unter besonderer Berücksichtigung eines Materiales von 80 sichergestellten Fällen gemustert. Das typische Aussehen und die Differentialdiagnose gegenüber intracerebralen Tumoren werden beschrieben und diskutiert.

RÉSUMÉ

Les auteurs étudient, en se basant en particulier sur une série de 80 cas vérifiés, l'examen radiologique des méningiomes intracraniens par la radiographie simple, l'angiographie et la pneumographie. Ils décrivent et examinent les aspects typiques et le diagnostic différentiel avec les tumeurs intracérébrales.

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FROM THE NEUROLOGIC HOSPITAL (DIRECTOR: PROF. K. HENNER), CHARLES UNIVERSITY, PRAGUE, CZECHOSLOVAKIA

COMBINATION OF ENCEPHALOGRAPHY WITH SMALL AMOUNTS OF AIR AND MYELOGRAPHY OF THE CERVICAL SPINAL CANAL

by

K. Lewit

In the paper presented by JIROUT on our method of myelography of the cervical spinal canal, the close relationship between encephalography and myelography of the cervical region was clearly shown. This method is particularly indicated for establishing a differential diagnosis of herniation of the cerebellar tonsils in cases of tumour or in cases of malformation of the craniocervical juncture.

Recent advances in our knowledge of the craniocervical syndrome — our daily clinical experiences confirming its frequency and importance in conditions varying from mere headache and migraine to disturbances of vestibular, cerebellar, and even motor-neuron function, *i. e.* conditions in which encephalography is usually performed — provided the main incentive to combine encephalography with myelography for the examination of the cervical spinal canal.

In a previous paper in 1949 we described a simple method for transferring air from the ventricular system to the subarachnoid spaces. This method consists in retroflexion of the head in the supine position to allow the air to escape into the spinal canal via the third and fourth ventricles; the patient is then raised slowly to the sitting position, thus directing the air to the subarachnoid spaces. The advantage of the method consists not only in the fact that about 20 ml of air is sufficient to obtain adequate demonstration of both the ventricles and the subarachnoid spaces; since the ventricular system is filled first and thereafter the subarachnoid

spaces, the detailed appearances of the ventricular system will be more distinct because superposition of details of the subarachnoid spaces will be avoided.

If we intend to combine encephalography and myelography we simply make use of the fact that during the manoeuvre mentioned air enters the spinal canal and outlines its ventral aspect. If, however, the technique of transferring air from the dorsal to the ventral cervical subarachnoid space, as described in the paper on myelography of the cervical spinal canal, is taken into account, the great possibilities of varying the procedure become apparent. The order in which the ventricles and the subarachnoid spaces (in particular those of the posterior fossa) are filled can be adapted to fit the case in question. The following typical combinations may serve as illustrations.

1. The ventricles are filled in the usual way with about 20 ml of air. During transfer, a view of the third ventricle can be taken and immediately afterwards we obtain contrast-filling of the ventral aspect of the cervical spinal canal. After seating the patient we obtain air-filling of the subarachnoid spaces on the convexity and of the basal cisterns.

2. We first fill the posterior fossa with the head bent forwards and at the same time obtain fillings of the dorsal aspect of the cervical spinal canal; we can now either continue as under (1), or we can immediately transfer the air from the dorsal aspect of the cervical spinal canal to the ventral aspect and, leaving the patient in the supine position, obtain films of the ventricles.

3. The patient may then again be brought to the sitting position, and the subarachnoid spaces and basal cisterns filled with the air which had been transferred from the dorsal to the ventral aspect of the cervical spinal canal.

4. Finally we can fill the spinal canal after ventriculography — first the ventral and subsequently the dorsal aspect, or transfer the air to the intracranial subarachnoid space.

The most frequent indication for a combination of encephalography and myelography is the differential diagnosis between arachnoiditis both of the cerebral hemispheres and of the posterior fossa, and a cervical disc lesion. The combination is also valuable in investigating the manifold syndromes arising from affections of the craniocervical juncture and, which is very important, the assessment of post-concussion syndromes in which changes may be found which affect the ventricles and the subarachnoid spaces, including the cisterns as well as changes in the intervertebral discs of the cervical spine, and cervical arachnoiditis.

We have found that the greatest advantage that our method of pneumography offers is its scope of application, *i. e.* the possibility it offers of being adapted to fit each individual case. Pneumography thus becomes a procedure permitting of the greatest flexibility.

SUMMARY

A technique is described by which a small quantity of air is used for the consecutive filling of the (undilated) ventricular system, the cervical spinal canal, the subarachnoid spaces and the cisterns. The order in which the various structures are filled may be varied to suit the case. The practical advantages are discussed.

ZUSAMMENFASSUNG

Eine Technik wird beschrieben, bei der eine geringe Menge Luft benutzt wird, um eine aufeinanderfolgende Füllung des Ventrikelsystemes (nicht erweiterten), des zervikalen Abschnittes des Spinalkanales, der subarachnoidalen Räume und der Zisternen zu erzeugen. Die Reihenfolge, in welcher die verschiedenen Hohlräume gefüllt werden, kann variiert und für jedem Fall angepasst werden. Die praktischen Vorteile werden demonstriert.

RÉSUMÉ

L'auteur décrit une technique permettant d'utiliser une petite quantité d'air pour remplir successivement le système ventriculaire (non dilaté), le canal rachidien cervical, les espaces sous-arachnoïdiens et les citernes. L'ordre dans lequel on remplit ces différentes cavités peut être modifié pour s'adapter à tous les cas. L'auteur en montre les avantages pratiques.

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AUS DER NERVENKLINIK (DIREKTOR: PROF. H. KRANZ) UND DER KINDERKLINIK DER UNIVERSITÄT VON MAINZ (DIREKTOR: PROF. H. U. KÖTTGEN)

NEURORADIOLOGISCHE BEMERKUNGEN ZUM MONGOLISMUS

von

K. H. Schiffer, K. Hartung und *H. Strubel*

Beim Betrachten von Schädelröntgenbildern Mongoloider ist man oft über die Variationsbreite und über scheinbar gegensätzliche Befunde, die sich sowohl an der Basis als auch an der Kalotte finden, überrascht. So sehen wir häufig eine Mikrocephalie, aber auch normal grosse, ja sogar zu grosse Schädel.

In der Abbildung 1 ist ein typischer Befund bei einem 37-jährigen Mongoloiden demonstriert. Bei einem zu kleinen, brachycephalen Schädel (Umfang 52.9; Schädel-Index 85.0) finden wir: Steilstand der Orbitadächer, Hochstand der Lamina cribrosa und des Planum sphenoidale im Verhältnis zur rucksackartig hängenden Sella und hochgradige Verkürzung der mittleren Schädelgrube in der Längsachse und Hochstand der kleinen Keilbeinflügel lateral. Ferner sehen wir: Unterentwicklung bzw. Fehlen der Keilbeinhöhlen und der Stirnhöhlen, unvollkommenen Nahtschluss und persistierende Stirnbeinnaht und am Gesichtsschädel Unterentwicklung des Nasenbeines und der Oberkieferknochen.

Es ist wohl unbestritten, dass beim Mongolismus eine Entwicklungsstörung der Schädelbasis vorliegt. Man sieht beim Mongolismus häufig eine Unterentwicklung der basolateralen Stirnhirnpartien und nicht selten eine Hypoplasie des Hypothalamus (VAN DER SCHEER, BENDA). Weiterhin haben neuropathologische Untersuchungen ergeben, dass sich

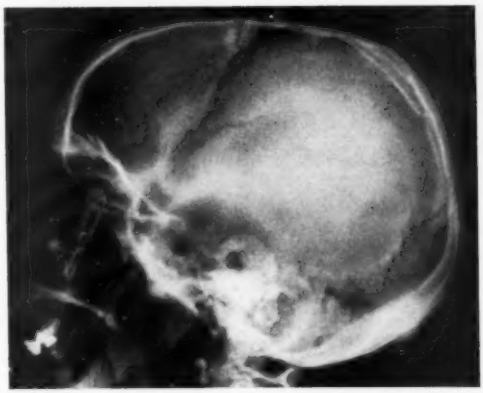
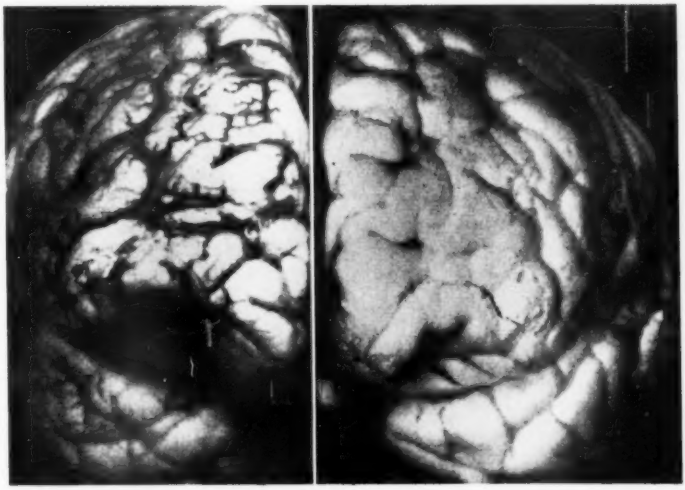


Abb. 1. 37-jähriger Mongoloider. Brachycephaler Schädel (Umfang 52.9; Index 85.0). Hochgradige Verkürzung der mittleren Schädelgrube in der Längsachse; Unterentwicklung bzw. Fehlen der Keilbeinhöhlen und der Stirnhöhlen, unvollkommener Nahtschluss; am Gesichtsschädel Unterentwicklung des Nasenbeines und der Oberkieferknochen.



a b

Abb. 2. a) Vogelkopfform bei Mongolismus. b) Normales Gehirn.

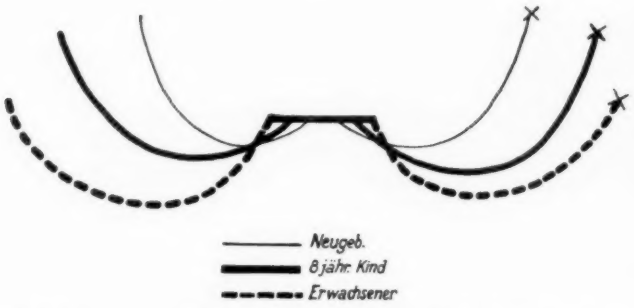


Abb. 3. Schematische Skizze der Senkung der Schädelbasisperipherie um die Hypophysengrube. Die in frühen Entwicklungsstadien zunächst schräg nach lateral ansteigenden kleinen Keilbeinflügel, auch die Felsenbeine, senken sich allmählich zur horizontalen Lage.

a b

Abb. 4. a) Sagittalschnitt durch den Schädel. Bei Embryo relativer Hochstand der vorderen Schädelgrube im Verhältnis zur Sella entsprechend der noch geringen Stirnhirnentwicklung. b) Bei Erwachsenen nähern sich höhenmässig die Rinne der vorderen Schädelbasis und der Sellaeingang. (Nach: DABELOW.)

die Veränderungen am Gehirn (Abb. 2a) mit Befunden am Binnenrelief der Schädelbasis weitgehend decken (JACOB).

Es erhebt sich nun die Frage nach dem entwicklungsmechanischen Ablauf der Verbildungen. Dabei können die Ergebnisse von DABELOW weiterhelfen. Unter normalen Verhältnissen kommt es nach diesem Verfasser infolge der allseitig überwiegenden Grössenentfaltung im Hemisphärenwachstum zu einer Senkung der Schädelbasisperipherie um die Hypophysengrube, wobei die Sella einen relativ ruhenden Mittelpunkt darstellt. Dieser Vorgang ist in der Abbildung 3 veranschaulicht.

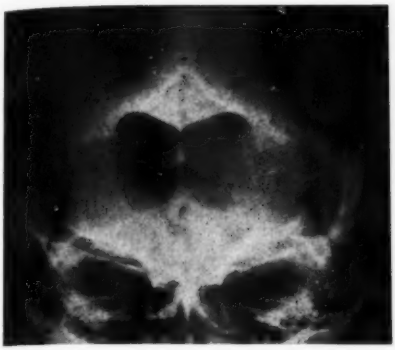


Abb. 5. Encephalographie eines kleinen Schädels bei einem Mongoloiden. Deutlicher Hydrocephalus, besonders des 3. Ventrikels. Die kleinen Keilbeinflügel und die Felsenbeine steigen lateralwärts an.

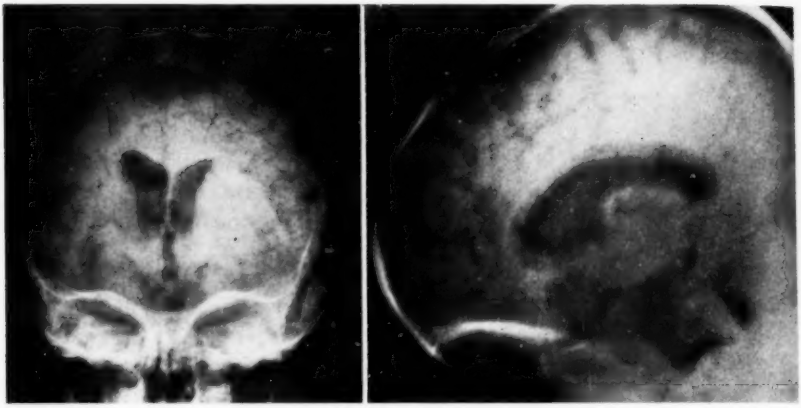
Im Sagittalschnitt durch den Schädel (Abb. 4) erkennt man beim Embryo den relativen Hochstand der vorderen Schädelgrube im Verhältnis zur Sella entsprechend der noch geringen Stirnhirnentwicklung, während beim Erwachsenen die Rinne der vorderen Schädelbasis und der Sellaeingang sich höhenmässig annähern.

Für unsere Betrachtung ergibt sich aus diesen entwicklungsmechanischen Vorgängen, dass beim typischen mongoloiden Schädel die normale Senkung der Basisperipherie und die Annäherung der medianen Strukturen der vorderen Schädelbasis und des Sellaeinganges zur Horizontalen infolge einer Entwicklungshemmung unterbleibt.

Die italienischen Autoren N. und V. Pende kamen zu den bemerkenswerten Ergebnissen, dass Mongoloide mit normal grossen oder zu grossen Schädeln einen Hydrocephalus zeigen. Es hat aber nicht jeder Mongoloide, der einen Hydrocephalus aufweist, einen normal grossen oder zu grossen Schädel.

In Abb. 5 ist das Encephalogramm des eingangs demonstrierten zu kleinen Schädels gezeigt, und in Abb. 6a Encephalographie eines Kleinkindes mit ausgeprägtem Mongolismus. Es besteht ein Hydrocephalus mit Betonung der rechten Seite. Im Seitenbild Abb. 6 b haben die medianen Strukturen des Schädels den typischen, aber nicht stark ausgeprägten Befund.

Bei der Deutung eines solchen Hydrocephalus bei Mongolismus ist einmal an die Möglichkeit zu denken, dass Schädel und Gehirn gleichzeitig so geschädigt wurden, dass bei dem Patienten eine mongoloide Mikrokranie mit Hydrocephalus e vacuo entstand. Die Entstehung des Hydrocephalus kann aber auch eine in der späteren intrauterinen oder in der frühen postnatalen Entwicklung durchgemachte Erkrankung anzeigen. In diesem Falle wird die gehemmte Entwicklung der Basisperipherie — wie man sie in typischen Fällen sieht — durch die sekundäre, prozesshaft erzwungene Ausweitung des Schädels partiell oder total gleichsam nachgeholt. Wir sehen dies eindrucksvoll an der Kontur der kleinen Keilbeinflügel im a.p. Bild, während die medianen Strukturen, insbesondere die Sellaregion keine so wesentliche Änderung erfahren und auch die typische Gesichtsbildung nicht mehr korrigiert wird. Der Patient ist in extremen



a b

Abb. 6. a) Encephalographie eines Kleinkindes mit ausgeprägtem Mongolismus und einem Schädelumfang von 45 cm im Alter von 1 ½ Jahren. Es besteht ein Hydrocephalus mit Betonung der rechten Seite. b) Im Seitenbild haben die medianen Strukturen des Schädels den typischen, aber nicht stark ausgeprägten Befund. Offene grosse Fontanelle. Weite Basalzisterne.

Fällen dann ein Mongoloider mit normal grossem, mitunter sogar zu grossem Schädel. Das Ausladen der Schläfenregion und der Horizontalstand der Keilbeinflügel im zweiten demonstrierten Falle ist der erste Schritt auf dem Wege dazu.

ZUSAMMENFASSUNG

Im Formenkreis des Mongolismus gibt es eine ziemlich scharf umschriebene Untergruppe mit Hypoplasie des Diencephalon. Mit dieser Hypoplasie ist eine abweichende Form der zentralen Schädelbasis verknüpft. Diese Formabweichung lässt sich auf eine Störung der Ausweitung der Schädelbasis zurückführen.

SUMMARY

A sharply defined group of cases of mongolism present hypoplasia of the diencephalon. This circumscribed cerebral hypoplasia corresponds to a deformation of the central portion of the base of the skull, which latter is due to an interference with the normal flattening-out movement in the development of the base.

RÉSUMÉ

Il existe dans le mongolisme un sous-groupe assez nettement délimité, caractérisé par une hypoplasie du diencéphale. Cette hypoplasie est liée à une anomalie de la forme du centre de la base du crâne. Cette anomalie de forme s'explique par un trouble du mouvement normal d'aplatissement de la base du crâne au cours du dévelop pement de l'ébauche cranienne.

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CLINIQUE NEUROCHIRURGICALE DE LA PITIÉ (PROF. PETIT-DUTAILLIS) ET SERVICE DE NEURORADIOLOGIE (DR. FISCHGOLD), PARIS, FRANCE

MICRORADIOGRAPHIE D'UN MÉNINGIOME DE LA VOÛTE

par

H. Fischgold, M. Juster, J. Metzger et *J. Écoiffier*

Dans plusieurs notes préalables nous avons insisté sur l'intérêt clinique de la microradiographie: elle dégage les structures osseuses de 2ème et 3ème ordre dont l'addition contribue à la formation de l'image radiographique. Une corticale perd son homogénéité et se révèle constituée par des ostéones dès que la tranche osseuse est assez mince pour annuler la superposition d'éléments denses et transparents. Une lacune osseuse, pour être visible sur l'image habituelle, nécessite la destruction d'un nombre suffisant de formations élémentaires.

Nous avons ainsi montré la résolution des densités et des clartés dans une clavicule (5) envahie par les métastases d'un cancer du sein.

Cette fois, la microradiographie est appliquée, dans le même esprit, à l'étude d'un cas de méningiome de la voûte du crâne. Après confirmation histologique, le volet osseux est inclu dans une matière plastique et le bloc obtenu débité en tranches d'environ 3 mm d'épaisseur. Une de ces tranches radiographiée, subit ensuite un amincissement progressif; ce dernier est souvent interrompu pour effectuer d'autres clichés. L'étude de ces radiographies et des agrandissements photographiques de préparations de plus en plus minces, a permis de retrouver les formations élémentaires de la voûte normale ou les aspects pathologiques qui les remplacent.

Fig. 1. Cliché de profil (tiré au Logetron). La bosse frontale est constituée par les parties molles épaissies, soulevées, détachées de la table externe. La lésion osseuse s'étend sur 6 à 7 cm de longueur: voûte épaissie dans son ensemble; le diploë s'éclaircit; la table externe paraît perforée par des formations osseuses perpendiculaires à la surface de l'os, effilées ou trapues, à bords nets.

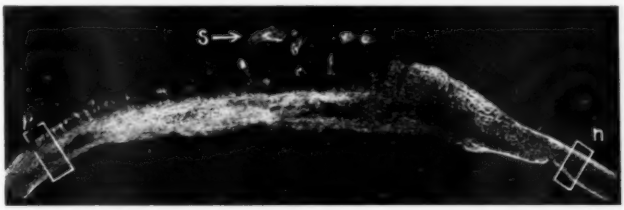
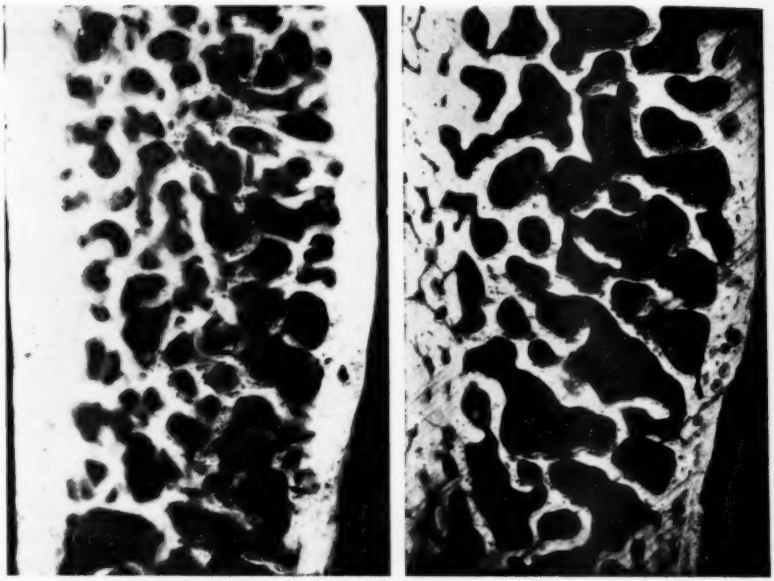


Fig. 2. Radiographie d'une tranche sagittale près de la ligne médiane. Épaisseur: 1.97 mm. Grandeur nature. Constantes: 35 kV, 10 mA, 12 minutes d'exposition.

Le rectangle *n* est découpé dans la voûte normale; le restant de la tranche montre des remaniements profonds des tables interne, externe et du diploë. Le rectangle *p* encadre une zône de faible transformation pathologique.

Sur la moitié gauche de la figure et contigüe au rectangle *p* on remarque une zône de condensation surmontée d'éléments osseux en palissade; suit, vers la droite un segment élargi avec fortes raréfactions osseuses, dans lequel la différenciation des tables et du diploë s'efface.

Dans les formations molles on remarque les spicules osseux, de différentes formes, se détachant de la voûte cranienne par des pédicules plus ou moins fins.



Épaisseur: 1.97 mm. Épaisseur: 0.26 mm.

Fig. 3. Voûte cranienne normale. Agrandissement × 10 du rectangle *n* de la fig. 2.

Sur la coupe épaisse la table externe (à gauche) et la table interne (à droite) se présentent sous la forme de bandes denses, homogènes, à contours linéaires.

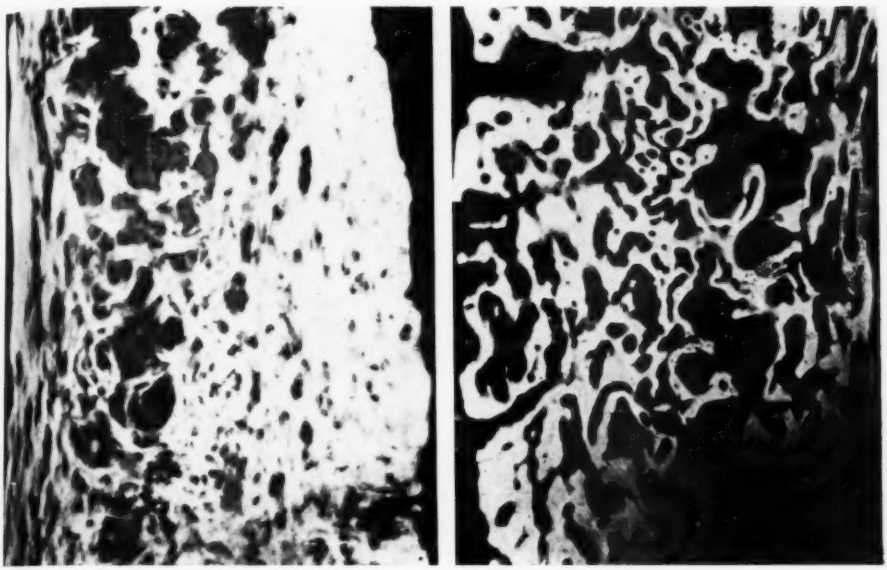
Au fur et à mesure que la tranche s'amincit (figure à droite), les tables externe et interne perdent leur homogénéité et laissent entrevoir une structure. *La table externe* est parcourue par des canalisations vasculaires qui la découpent et lui donnent un aspect polyédrique. *La table interne*, par contre, reste plus homogène; des ostéones apparaissent au voisinage du tissu spongieux. *Le diploé* est caractérisé par des mailles arrondies ou polygonales. Les travées, à bord net, renferment des mailles généralement arrondies.

Notion ess ntielle: L'amincissement de la tranche rend le diploë plus transparent mais le dispositif des travées reste toujours le même. (Les raies parallèles obliques des tables sont des artéfacts d'autant plus visibles que la tranche est plus fine.)

Pour l'inclusion, la confection des coupes et la technique microradiographique, se référer aux publications antérieures (3, 4 et 5).

Les figures proviennent d'un sujet de 59 ans, porteur d'une bosse frontale gauche, indolore, évoluant depuis cinq ans. L'artère temporale superficielle est dilatée, saillante et sinueuse. Il n'y aucun autre symptôme clinique.

Le diagnostic confirmé par la radiographie cranienne (Fig. 1) est complété par artériographie est suivi d'intervention (PETIT-DUTAILLIS). Un méningiome hyperostosant frontal gauche, empiétant sur le sinus longitudinal supérieur, a été trouvé.



Epaisseur 1.97 mm. Epaisseur 0.22.

Fig. 4. Voûte cranienne remaniée par le méningiome. Agrandissement × 10 du rectangle *p* de la fig. 2. Tendance à l'uniformisation du diploë et des tables interne et externe, s'accentuant au fur et à mesure que la tranche s'amincit. Les mailles diploïques sont encore visibles sur une bande étroite au milieu de l'os.

Comparer les images droites des Figs. 3 et 4: table externe, interne et travées du diploë sont parcourues par des canaux de diamètre variable qui les dissocient. La dissociation est plus marquée dans la table interne.

Une préparation de 2 mm d'épaisseur permet une orientation microradiographique d'ensemble (Fig. 2). La tranche présente dans sa partie pathologique de nombreux canaux vasculaires dont certains se laissent poursuivre sur toute l'épaisseur de la préparation. Sur cette préparation on découpe de petits segments (*n* et *p*). Les figures suivantes agrandissent, à différentes épaisseurs, les rectangles *n* et *p* ainsi que le spicule osseux *s* indiqué par la flèche. On pratique l'analyse de la voûte normale (Figs. 3 et 5) et pathologique (Figs. 4 et 6) sur ces segments.

L'agrandissement modéré rend visibles les structures élémentaires à condition que la préparation soit suffisamment mince.

Ainsi la figure 3 (à droite) nous prouve que l'homogénéité des tables n'est qu'apparente, due à la superposition des éléments denses et transparents aux rayons roentgen. La table externe est parcourue par des canalisations vasculaires qui la découpent et lui donnent un aspect poly-

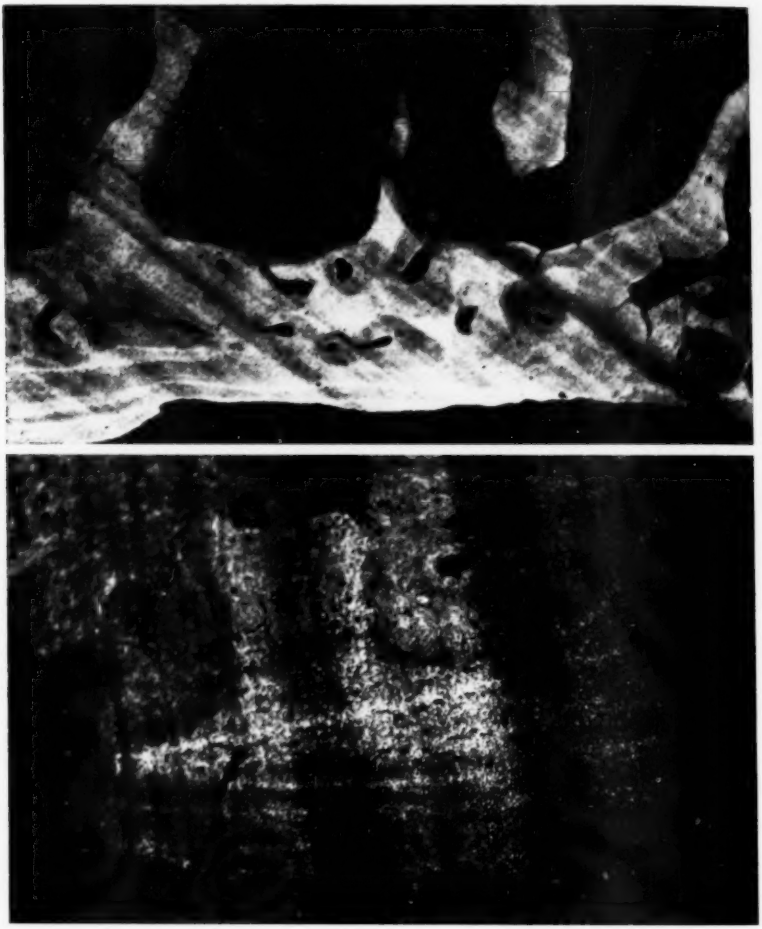
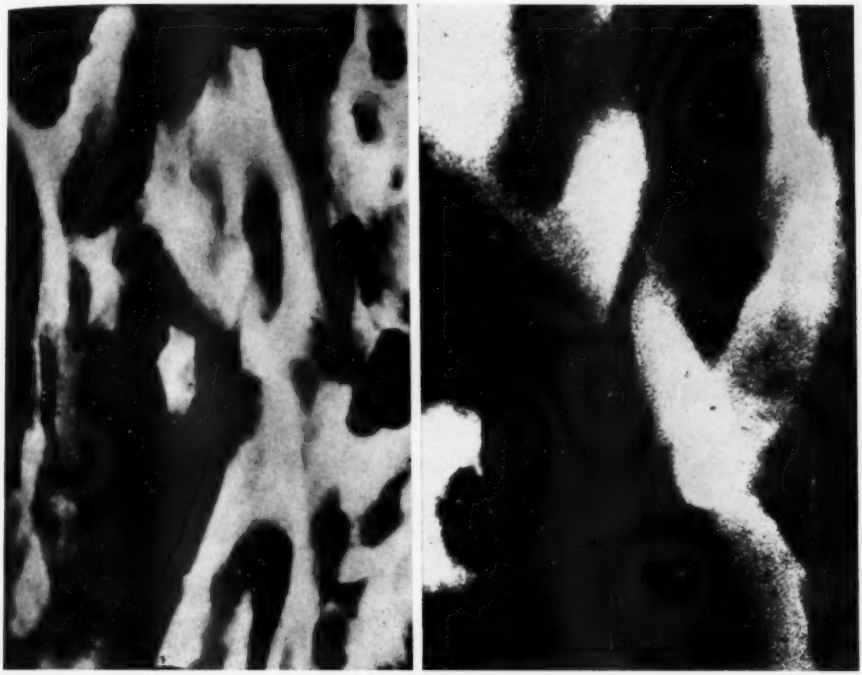


Fig. 5. Table interne normale. Rectangle *n* de la fig. 2.

En haut: Agrandissement × 50. Épaisseur 0.07 (70 microns). On remarque dans la table interne le système lamellaire de la «tabula vitrea», en contact avec la dure-mère (partie inférieure de la figure) et les ostéones, au voisinage du diploë.

En bas: Agrandissement × 140. Le système lamellaire se détache davantage. Les ostéoplastes longent les lamelles de la «tabula vitrea» et se disposent en couches concentriques autour des canaux de Havers.



Épaisseur 0.17 mm.

Fig. 6. Table interne pathologique (rectangle *p* de la fig. 2).

À gauche: Agrandissement × 50. Les lamelles de la «tabula vitrea» apparaissent déchiquetées et dissociées, entrecoupées et perforées par des canaux; l'espace occupé par les formations non calcaires est agrandi par rapport à celui de la substance osseuse. On ne retrouve plus de formations ostéoniques. Morphologiquement, la table interne est méconnaissable. *À droite:* Agrandissement × 140. Aux transformations mentionées s'ajoute l'absence des ostéoplastes, si caractéristiques dans la table interne normale.

édrique. La table interne, par contre, reste plus homogène; des ostéones apparaissent au voisinage du tissu spongieux. Le diploë est caractérisé par des mailles arrondies ou polygonales. Les travées, à bord net, renferment des mailles généralement arrondies. Une notion essentielle est que l'amincissement de la tranche rend le diploë plus transparent mais le dispositif des travées reste toujours le même.

La figure 4 (à droite) montre que la différenciation de la voûte pathologique en tables et diploë tend à s'atténuer.

En agrandissant 50 et 140 fois des préparations minces de 200 à 15

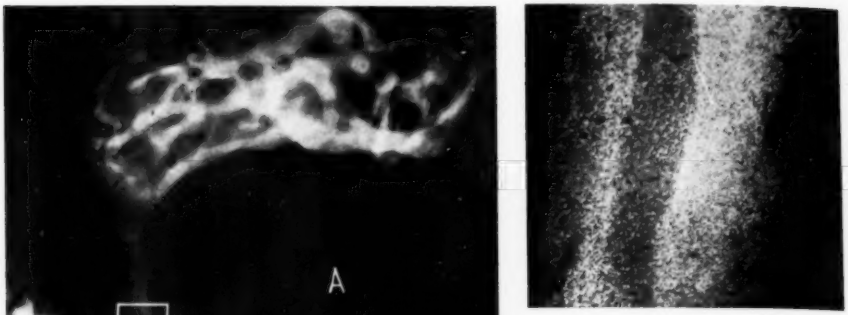


Fig. 7. Spicule marqué par la flèche (s) sur la fig. 2. *À gauche:* Agrandissement × 10. Le spicule se détache de la table externe remaniée par un pédicule qui se divise en une branche plus épaisse et une branche filiforme centrée par un canal vasculaire; le pédicule supporte le renflement terminal sur lequel on retrouve un aspect alvéolaire. *En haut:* Agrandissement × 140. Portion encadrée du pédicule filiforme; le dépot calcaire est disposé autour du canal. Aucune organisation de cette substance calcaire ne peut être discernée. (Le grain provient du film.)

microns on reconnaît les ostéones, les lamelles de la tabula vitrea et les ostéoplastes sur la table interne normale (Fig. 5) ainsi que leur remplacement par une structure osseuse plus grossière sur l'os méningiomateux (Fig. 6).

De même, l'agrandissement de 50 et 140 fois d'un spicule (Fig. 7) illustre le rôle capital joué par les vaisseaux néoformés dans l'envahissement et l'hyperostose de l'os.

Il n'est pas nécessaire de discuter dans cette note iconographique la bibliographie importante qui depuis Louis (8) jusqu'à Cushing (2) et Lindgren (7) est consacrée aux modifications osseuses et radiographiques des méningiomes.

Dans l'état actuel, il s'agit de réduire l'image obtenue sur le vivant à des formations microradiographiques, en jetant ainsi un pont entre la radiographie clinique et l'histopathologie.

RÉSUMÉ

En appliquant la technique microradiographique à l'étude d'un méningiome de la voûte, les auteurs essaient d'expliquer les signes radiographiques cliniques par des structures osseuses élémentaires microradiographiques. Les formations élémentaires (ostéones, ostéoplastes) n'apparaissent que sur des préparations minces au-dessous de 300 microns, radiographiées et agrandies photographiquement.

ZUSAMMENFASSUNG

Unter Benutzung einer mikroradiographischen Technik beim Studium eines Meningeomes des Schädeldaches ist der Versuch unternommen worden, klinische Röntgenbefunde auf der Basis mikroradiographischer elementärer Knochenstrukturen zu erklären. Derartige Formelemente (Osteonen, Osteoblasten) sind nur in dünnen Schnitten, die weniger als 300 Mikron dick sind, röntgenologisch und photographisch vergrössert darstellbar.

SUMMARY

A meningioma of the vault of the skull was examined microradiographically in an attempt to correlate the clinical roentgen findings with the elementary bone structures. These formations are demonstrable by the radiography and photographic enlargement of preparations less than 300 microns in thickness.

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INTRACRANIAL CALCIFICATIONS FOLLOWING TUBERCULOUS MENINGITIS IN CHILDREN

by

John Lorber

It has been shown in an earlier study (LORBER 1952) that intracranial calcifications frequently develop 18 months or more after the onset of tuberculous meningitis. At the time of the first report such calcifications were detected in 17 out of 25 consecutive cases who had been followed for a minimum of $2^1/_2$ years from the onset of the meningitis. Since then the systematic study has continued.

Present investigation

This paper reports the results in 129 patients who developed tuberculous meningitis before the 30th of June 1955 and who were roentgen examined at least once 21 months or more after the onset of their meningitis. In most of these, serial roentgenograms were obtained at 6 to 12 months intervals. Of these patients, 119 are alive, and 10 died after a prolonged or recurrent illness 21 months to 6 years from the beginning of treatment. In 4 fatal cases intracranial calcification was demonstrable before death, and in two others calcified lesions were detected at necropsy. All the 119 surviving patients are free from evidence of active infection, but 16 have permanent neurological sequelae or suffer from convulsions.

Table 1

The time when calcifications were first detected

Treatment group	Months after admission			Total
	15 to 24	25 to 36	37+	
S.M.	3	18	4	25
S.M. & PAS	6	10	5	21
S.M. & I.N.H.	7	5	5	17
All groups	16*	33	14**	63

* 7 S.M. treated not roentgen examined by 24 months.
** 5 not roentgen examined before the 37th month.

None of these children had intracranial calcifications at the onset of their illness. Subsequently, pathological intracranial calcifications were radiologically demonstrated during life in 63 patients (48.7 %). In those who had serial roentgenograms taken it was possible to observe the gradual development of the calcifications, early traces of which were frequently detected only in retrospect after more definite evidence had been obtained. The earliest detectable calcifications occurred 15 months after the onset of the meningitis in one child. In 50 cases the calcifications were seen within 3 years of the onset of the meningitis and in 13 in the fourth and fifth years. In 5 of the last mentioned 13 cases, films have not been taken within 3 years of admission and the appearance of the calcifications when these were first seen suggested that they have been there for a long time (Table 1).

As in 57 negative cases roentgen examination of the skull was performed between 3 and 7 years after admission; it is evident that most of the calcifications develop within 3 years of the onset of the meningitis. It is possible nevertheless that in some of the few negative cases who have been followed for less than 5 years calcifications may yet develop on further observation.

Types of calcifications

Calcifications were demonstrated in some cases in the pineal, the choroid plexuses or in the falx, but as such calcifications may be physiological, they will not be considered further.

Two main types of pathologic calcifications were seen. The commoner were calcifications of the meninges at the base of the brain and less common were intracerebral calcifications. In 3 children both types were seen together.

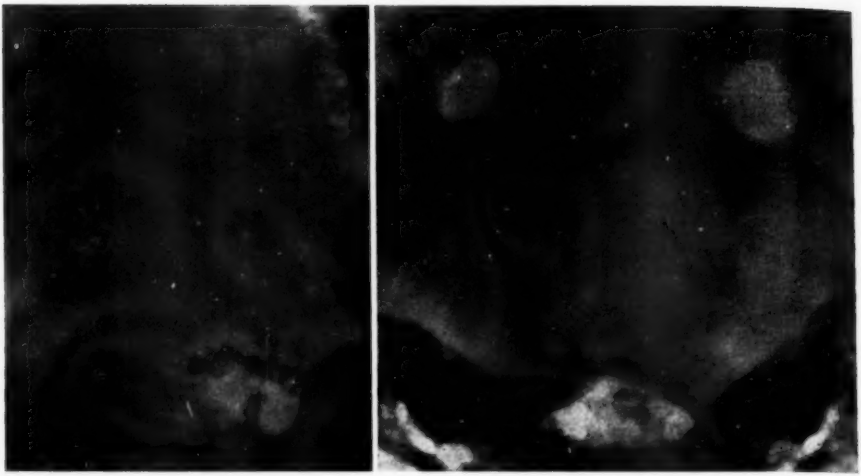

Fig. 1. Typical example of massive meningeal calcification in a blind child, 3 years after the onset of the meningitis. The calcification is bilateral and occupies the chiasmatic and ambient cisterns.

Meningeal calcifications. These were seen in 49 cases. Most of them were at the base of the brain, usually immediately above the sella turcica, either over the anterior or posterior clinoids, or behind the posterior clinoids, or extending further back. They were single in 9 cases. More commonly they were composed of clusters of small calcifications either in plaques of straight, curved or branching arrangements, or in a concentric ring. In some cases large conglomerate masses developed. Their situation corresponds well with the ambient cistern and the chiasmatic cistern which are the commonest sites of the maximal exudate and of the obstruction of the cerebrospinal fluid pathways in the active phase of the meningitis. (See the accompanying figure.) On account of their situation their presence is easily detected on lateral views, but are very difficult to demonstrate on postero-anterior views of the skull. They are situated either on one or both sides, very near to the midline. In the course of time these calcifications became denser and more defined and none have disappeared once they were definitely identified. In five patients extensive calcifications, measuring 10 × 10 mm or more, developed immediately above and in front of the anterior clinoids and three of these were blind, presumably due to involvement of the optic nerve. One of them died and the optic chiasma and the optic nerve were completely incorporated in a calcified mass and were not identifiable at necrospy. In three patients the site of the calcifications corresponded with those of the Sylvian fissure.

Table 2

Intracranial calcifications following tuberculous meningitis related to the stage on admission
Minimum follow-up: 2 years

Stage on admission	All cases	Calcifications					
		Basal		Cerebral		Total	
		No.	%	No.	%	No.	%
Early	33	7	21	5	15	12	36
Intermediate	78	32*	41	11*	14	40*	51
Advanced	18	10	55	1	5	11	61
Total	129	49*	38	17*	13	63	49

* Includes 3 cases with both types of calcifications.

The incidence of meningeal calcifications was 21 % of 33 early cases, 41 % of 78 intermediate cases and 55 % of 18 advanced cases. Among 42 patients treated with streptomycin alone the incidence of meningeal calcifications was 48 %, among 39 treated with streptomycin plus PAS it was 38 % and among 48 treated with streptomycin, PAS and isoniazid it was 29 % (Table 2). Fifteen particularly severe cases failing to respond to standard antibiotic treatment received a course of intrathecal tuberculin (P.P.D.) in addition. Of these only 5 developed meningeal calcifications. Of 18 advanced cases on admission, eleven did not receive tuberculin treatment and meningeal calcifications developed in seven; 7 received P.P.D. and calcifications developed in three, but the latter group was observed for a shorter time.

Cerebral calcifications. In 17 patients calcifications were detected in the brain substance. None of these were in the cerebellum. In 15, the deposits were small, irregular in outline and their diameter was only a few millimeters. In two cases, however, they were large, exceeding 10 mm in diameter and presumably represented large intracerebral tuberculomata. In one of these children the tuberculoma was situated in the left temporal lobe and was identified there by focal Eeg changes as well as by roentgen rays. This child suffered from fits. The other child, whose lesion is in an occipital lobe, is at present perfectly well and has a normal Eeg. The incidence of intracerebral calcification is as high in early as in intermediate and advanced cases (Table 2).

It is seen from Table 3 that progressively more efficient treatment, especially when isoniazid was used, apparently decreases the incidence of intracranial calcifications. It must be remembered, however, that those who were treated with isoniazid have been observed for the shortest period and that the figures in this group may not be final.

Table 3

Intracranial calcifications following tuberculous meningitis related to treatment
Minimum follow-up: 2 years

Treatment	All cases	Calcifications					
		Basal		Cerebral		Total	
		No.	%	No.	%	No.	%
S.M.	42	20*	48	7*	16	25*	60
S.M. & PAS	39	15	38	6	15	21	54
S.M. & I.N.H.	48	14*	29	4*	8	17*	35
Total	129	49*	38	17*	13	63*	48

* Includes cases with both types of calcification.

Children with severe neurological sequelae. Twenty children survived with permanent neurological sequelae, including blindness, hemiplegia, paraplegia, sexual precocity or more extensive physical and mental defect. Intracranial calcifications were present in 12 of these. Among these, 8 had been treated with streptomycin as the only antibiotic and only one was treated with intrathecal tuberculin. Seven who had streptomycin plus PAS or isoniazid were also treated with intrathecal tuberculin, and intracranial calcification was present in only two. As six of these seven have been observed for over 3 years it is likely that intrathecal tuberculin was an important factor in the diminished incidence of calcification in this bad group of cases.

The dead children. In three children calcified lesions were detected in the central nervous system at necropsy. On one child, who died 21 months after the beginning of treatment a post-mortem roentgenography of the brain showed some faint flecks of calcification in the region of the temporal lobe. These could not be located on slicing the brain. In the spinal canal, however, the meninges, and particularly the dura, were found to be calcified, and even ossified. The second late death occurred in a child 29 months after the beginning of treatment. Faint suspicion of calcification was detected on a roentgenogram of the skull five months before she died. At autopsy, roentgen examination of the brain was performed and a characteristic deposit was found in the left temporal lobe. This was subsequently located by further roentgenograms of the brain slices and was found to be within the brain adjacent to the Sylvian fissure. It was composed of clusters of small calcified foci, but no tuberculous granulation tissue could be detected at the same site. The third child died in a relapse of his meningitis 6 years after admission. He had most

extensive calcification immediately in front of and above the sella, and he was blind. At necropsy, massive calcification obliterated the chiasmatic cistern and the optic nerve; the optic tracts were completely within the calcified mass and not identifiable.

Conclusions

Intracranial calcifications very frequently develop following recovery from tuberculous meningitis. They usually become demonstrable 18 months to 3 years after the onset of the disease. They most commonly develop in the meninges at the base of the brain and less often in the small cerebral tuberculomata (Rich foci). Their incidence was 64 % in 42 cases treated with streptomycin alone, 54 % in 39 cases treated with streptomycin and PAS and 35 % in 48 patients treated with streptomycin, PAS and isoniazid. They were commonest in very severe cases who recovered with residual defects except when intrathecal tuberculin was used as an adjuvant.

Meningeal calcifications were least frequent in early cases and most frequent in advanced cases, but the incidence of intracerebral calcifications did not depend on the stage of the disease on admission. Calcifications are less frequent in patients who have been treated with isoniazid in addition to streptomycin and PAS.

SUMMARY

Serial roentgenographic examination of the skull was performed in 129 children who had recovered from tuberculous meningitis. Intracranial calcifications became demonstrable in 63 patients mostly between 18 months and 3 years after the onset of the disease. The large majority of these calfifications occurred in the basal meningeal exudate in the vicinity of the sella turcica, and the minority in small intracerebral tuberculomata.

ZUSAMMENFASSUNG

Periodische Röntgenuntersuchungen des Schädels wurden bei 129 Kindern ausgeführt, die von einer tuberkulösen Meningitis genesen waren. Intrakranielle Verkalkungen wurden bei 63 Patienten, hauptsächlich zwischen $1^1/_2$ bis 3 Jahren nach Beginn der Erkrankung sichtbar. Die meisten Verkalkungen traten in dem basalen meningealen Exsudat in der Nachbarschaft der Sella turcica auf; in den kleinen intracerebralen Tuberkulomen sah man nur eine geringe Anzahl.

RÉSUMÉ

Cent vingt-neuf enfants guéris de méningite tuberculeuse ont subi des examens radiographiques répétés du crâne. Des calcifications intracraniennes apparurent chez 63 de ces malades, pour la plupart entre 18 mois et 3 ans après le début de la maladie. La grande majorité de ces calcifications siégeait dans l'exsudat méningé de la base, au voisinage de la selle turcique, et la minorité dans de petits tuberculomes intracérébraux.

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LOCALIZED ATROPHY OF THE SPINAL CORD

by

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A perusal of the roentgenologic literature has revealed that mention of atrophy of the spinal cord has been made only by ODÉN (1953) and MURTAGH et coll. (1955). The former paper was accompanied by an air myelogram from a case of syringomyelia in which the cervical part of the cord was enlarged whereas the thoracic portion was abnormally thin. This appearance must be regarded as characteristic and we have encountered similar cases.

MURTAGH et coll. studied only the cervical spinal cord, using air myelography without tomography, and in commenting upon a film from a case with an abnormally slender cervical cord (diagnosis: syringomyelia) they stated that the atrophy was not shown by myelography with Pantopaque. They mentioned other cases of degenerative lesions of the cervical cord without giving details and their criteria appear to be rather vague. LINDGREN has stated (1954) that gas myelography is superior to myelography with a positive contrast medium for a determination of the size of the spinal cord. Even extensive changes may escape detection when a positive contrast medium is used.

More localized atrophic lesions of the spinal cord, like those now presented, have to our knowledge not been mentioned in the roentgenologic or patho-anatomical literature. The employment of suboccipital air myelography combined with tomography by the method of LINDGREN (1939) enabled us to establish the diagnosis in the six cases now

Fig. 1. Case 1. Atrophy of the spinal cord, probably due to arteriosclerosis.

Fig. 2. Case 2. Probable atrophy of the cord due to dehydration, incipient Charcot-Marie-Tooth disease.

Fig. 3. Case 3. Possibly disseminated sclerosis, atypical lateral amyotrophic sclerosis.

reported upon. The slight changes could probably not have been demonstrated by means of iodized oils, and water-soluble contrast media can be used without risk only caudal to the thoracic region.

A common feature of the appearances is a reduction in thickness of the cord over a distance of a few centimetres, whereas above and below the cord is normal, or at least more normal. The proof that this reduction in size is a true one is afforded by the fact that it is demonstrable at the same level in the same case in all the tomographic sections; thus, the decreased diameter cannot be due to the cord leaving the tomographic layer. The diagnosis was verified by autopsy in one case. The Wassermann reaction was negative in all cases.

Case reports

Case 1 (Fig. 1). Female, aged 68, with progressive paresis of the left leg and difficulty of coordination for the previous two years; paresis of the right leg for a shorter period. On examination there was marked left-sided and slight right-sided paresis of the legs, partic-

ularly distally. Deep reflexes diminished or abolished. Babinski sign positive on both sides. Analgesia and thermanesthesia below the level of the umbilicus. Lower abdominal reflexes absent. B. P. 180/80.

Electromyography. No active innervation but marked reaction of the left anterior tibial muscle to a stimulus to the sole of the foot.

Suboccipital air myelography. The cord was reduced in size from about 7 to about 4 mm diameter (in this and the following cases measured in the tomogram) for a distance of about 2 cm at the level of Th7. Diagnosis: Atrophy of the cord, due probably to arteriosclerosis.

Case 2 (Fig. 2). Male, aged 20, with a history of gastric ulcer when 17 years old. Whilst in the Persian Gulf 5 months previously he had been exposed to extremes of temperature and developed cerebral symptoms of bouts of prolonged unconsciousness, headache, nausea, vomiting, and dizziness together with low back pain. He improved on his return home but complained of pain in both legs and had to stay in bed because of disturbances in coordination. On examination his general condition was poor. Slight loss of dorsal flexion on the right foot. Very thin legs with increasing wasting distally. Right Achilles reflex absent; plantar reflexes diminished and hypoesthesia distally on both legs. Laboratory findings negative. *Eeg:* Moderate tendency to cerebral paroxysm under Pentazole.

Suboccipital air myelography. Cord regularly reduced in thickness from about 7 to about 5 mm from the level of Th11 downwards, *i. e.* to the level where the intumescentia lumbalis should be visible. Diagnosis: probable atrophy of the cord due to dehydration, incipient Charcot-Marie-Tooth disease.

Case 3 (Fig. 3). Male aged 49. During a febrile spell 10 years previously, he developed paralysis of the left leg, left arm, right leg, and right arm, in that order. Remission occurred within a few weeks but the fever persisted. Took active part in gymnastics during the intervening period until 6 months previously when he developed paresis of the left arm and later of the left leg. At no time were these signs referable to the cranial nerves. On examination: tremor of the tongue, brisk fibrillations in both arms and left quadriceps and slight atrophy of the muscles of the left hand with moderate supranuclear paresis of left arm. Hyperactive deep reflexes with left-sided preponderance. Extensor plantar reflexes. Laboratory findings normal except for slight increase in the albumen content of the spinal fluid.

Suboccipital air myelography. Kyphosis of the Scheuermann type and, as described by LINDGREN (1941), the cord lay close to the posterior surface of the vertebra, in the present case Th7, which formed the upper limit of the kyphosis. Cord decreased in diameter from about 7 to about 5 mm for a distance of 1 cm at the level of Th6. Diagnosis: possibly disseminated sclerosis, atypical lateral amyotrophic sclerosis.

Case 4 (Fig. 4). Male, aged 52. During the previous 10 months regular progressive monosymptomatic flaccid paresis beginning in the right foot and spreading up the leg; the left leg was also involved. No sphincter disturbances. On examination there was marked flaccid paresis of the right leg. The knee could just be extended against the resistance of the weight of the leg. No flexion of the right hip. Paresis of approximately the same distribution on the left side but less marked. Atrophy of the muscles corresponding to the degree of paresis. Left patellar reflex moderately brisk, the right weaker. Cutaneous and deep sensibility normal; no ataxia. Constant coarse fibrillations in both legs. Both plantar reflexes absent. Biopsy from the right quadriceps showed muscle atrophy with some interstitial inflammatory reaction.

Fig. 4. Case 4. Possibly lateral amyotrophic sclerosis and anterior spinal artery syndrome.

Fig. 5. Case 5. Cord decreased in diameter from about 8 to about 7 mm for a distance of about 4 cm at the level of Th10.

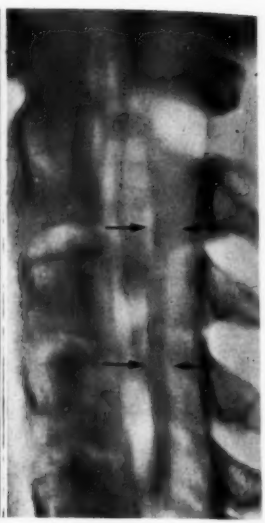

Fig. 6. Case 6. Cervical spinal cord of about 4 mm width. Protrusions of disc between C6 and C7.

Electromyography. Right quadriceps muscle, left anterior tibial muscle, and lateral head of the left gastrocnemius muscle: single oscillations upon maximum contraction plus synchronization. Laboratory findings normal.

Suboccipital air myelography. The cord exhibited a visible but barely measurable narrowing over a distance of about 1.5 cm at the level of Th9. Diagnosis: possibly lateral amyotrophic sclerosis (purely lumbar) and possibly anterior spinal artery syndrome.

Case 5 (Fig. 5). Male, aged 64. Bilateral paresis of the peroneus muscles from childhood. A brother was stated to have had a similar condition. During the previous 20 years he had developed fixed pupils, mild papilloedema, and peripheral atrophy in all four limbs increasing almost to paralysis of the hands and feet. Ventriculography 12 years previously had shown an old haematoma lying centrally in the right hemisphere. On examination he had small fixed pupils, bilateral impairment of hearing following otitis media, and left-sided paresis of the recurrent laryngeal nerve with indistinct speech. Marked muscular atrophy of both forearms and hands and paralysis of the fingers were present. There were corresponding phenomena of the lower limbs. Sensibility normal. Romberg sign positive. Spinal fluid: slightly increased values, 4/3 cells, 68 mg % protein. Histologic examination of cortical biopsy: definite evidence of lipidosis although the cells contained less lipid than normal in this condition; there were probably also substances of the so-called pre-lipid form in the cells. The general appearances were similar to those described as characteristic of heredopathia atactica polyneuritiformis (Refsum's disease).

Suboccipital air myelography. Cord decreased in thickness from about 8 to about 7 mm for a distance of about 4 cm at the level of Th10.

Case 6 (Fig. 6). Male, aged 40. Thirteen years previously he began to experience stiffness of the left leg intermittent at onset but later progressing and spreading to all limbs. During the previous 6 months he had increasing stiffness of the back and painful spasms of the legs. No paraesthesia or sphincter disturbances. Repeated admissions to hospital had never shown any other abnormalities than those indicated by electromyography 3 and 2 years previously: possible involvement of cells of the anterior horn.

On examination: a nervous slightly depressed patient. Horizontal rotatory nystagmus to the left. The vertebral column was fixed and attempts at flexion elicited violent and painful spasms of the legs. Limbs: diffuse spastic paresis, most marked on the left side; more strength in the proximal than in the distal muscle groups. The right arm could be raised to the vertical position but the left could hardly be raised from the couch. No arm reflexes could be obtained. Sensibility tests for pain, touch, and temperature were normal. Spastic paralysis of the legs. Abdominal reflexes absent.

Suboccipital air myelography. This was misinterpreted. On re-examination of the films after the operation a 4 mm wide band representing the cord and extending the length of the cervical spinal canal was detected. The thoracic spine was normal. Protrusions of the disc between C6 and C7 led to the operative procedure and following laminectomy of C5, C6, and C7, the cord was found to be reduced to a tape, a few millimeters in width. (It should be mentioned that myelography with Pantopaque was carried out after the air myelography had confirmed the presence of the slipped disc without providing any information about the cord.)

Six months after the operation the patient died in a state of emaciation with severe urinary infection. The gross appearance of the cord in the cervical segment was as described; the more caudal segments were normal in size and appearance. Section of the cervical cord revealed a longish flat cyst, characteristic of syringomyelia. Microscopy confirmed the diagnosis.

There thus appears to be no one collection of clinical signs which point to localized atrophy of the spinal cord. On the contrary the clinical features in the present cases very much differ and the diagnosis was doubtful in all the cases owing to the uncharacteristic nature of the signs. Suboccipital air myelography therefore appears to be of value, particularly in cases of doubt as to whether a condition is of cerebral or medullary origin, and in confirming and locating a puzzling lesion of the medulla.

SUMMARY

Six cases of lesions of the spinal cord exhibiting uncharacteristic signs are reported. Localized atrophy of the cord was demonstrated in all the cases by means of suboccipital air myelography.

ZUSAMMENFASSUNG

Sechs Fälle mit Erkrankungen des Rückenmarkes, die uncharakteristische und verschiedenartige Symptome hervorriefen, werden berichtet. Suboccipitale Luftmyelographie zeigte in allen Fällen eine lokalisierte Atrophie des Rückenmarkes.

RÉSUMÉ

Les auteurs présentent six cas de lésion de la moelle épinière se manifestant par des symptômes variés et non caractéristiques. Dans tous ces cas, la myélographie gazeuse sous-occipitale a permis de mettre en évidence une atrophie localisée de la moelle.

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FROM THE NEUROLOGICAL DEPARTMENT, STRAKONICE HOSPITAL, CZECHOSLOVAKIA

EPIDURAL PNEUMOMYELOGRAPHY

by

J. Kohout

This communication deals with 20 cases of epidural air filling of the spinal canal, in particular in the lumbar region. The first two trials were made in April 1954. According to LINDGREN there is a danger of air embolism from injury to the venous plexus by the needle during the filling of the epidural spaces with air and, for this reason, we abandoned the method. Since, however, we found no evidence in the literature that the method had ever been employed, we introduced it again in March 1956.

Technique

Normal lumber puncture is first performed with the patient on his side, and 30 to 60 ml of spinal fluid are withdrawn. The needle is then carefully retracted until the spinal fluid ceases to flow and a 20 ml syringe is attached. The piston of the latter is slightly withdrawn, as usual, to ensure that no blood is introduced, and the air is injected into the spinal canal.

In recent months we have been performing lumbar puncture by inserting the needle directly into the epidural space without penetration of the subarachnoid space. The epidural space of the canal is filled with air until a given pressure (causing the piston of the syringe to be pressed back) is established. At this point no more air should be injected because it escapes through the intervertebral foramina; even if the mentioned pressure

is not attained some of the air escapes if the roentgen investigation takes too long. The escaped air usually accumulates in the paravertebral spaces along the psoas muscles.

Forty to 100 ml of air are usually injected with this method. An exception was made in two cases. The first was one of a neurinoma of the left nerve root of D 10 verified at operation. After the removal of 30 ml of spinal fluid, and the injection of 20 ml of air, the pressure rose sharply and, on performing subarachnoidal air myelography, it was possible to inject 70 ml of air. In the second case (osteoma of D 12) epidural insufflation was performed twice with 100 ml and 120 ml of air without any sign of raised pressure. Only a small amount of air was observed in the canal in the first film, the following one showing an accumulation of air below the left side of the diaphragm.

Fig. 1. Normal case. Epidural air filling of lumbar spine, lateral view.

We hoped by employing this method to achieve better demonstration of a prolapsed intervertebral disc at L5—S1 as well as epidural processes. In practice, other considerations arose including the possibility of filling the epidural spaces along the whole spine and those of the skull.

We obtain the following standard views: a lateral view with a vertical beam, an anteroposterior in the supine position with a vertical beam, and two anteroposterior views with a horizontal beam. The examination is, if necessary, supplemented with tomography when lateral views with a vertical beam and with the patient bent forwards and backwards are obtained.

Our experiences to date may be summarised as follows. A prolapsed intervertebral disc at L5—S1 is better shown by the method described than by subarachnoidal air myelography. The contour of the dural sac is usually best seen in the lateral view with a vertical beam. The width of the epidural space is not the same in all parts of the spinal canal. Normal air myelography may be combined with epidural air filling when it is possible to demonstrate the meninges in the cervical region. The narrowing of the epidural spaces and the widening of the dural sac in localized congenital enlargement of the spinal canal may be demonstrated. Among the 20 cases were 2 in which spinal tumours were clearly demonstrated by this method and verified at operation. The most important difference between a localized congenital enlargement of the spinal canal

Fig. 2

Fig. 3

Fig. 2. Medulloblastoma at level of L2—L3, verified at operation. Lateral tomogram. Accumulation of air at level of L3.

Fig. 3. Normal case. Combined subarachnoidal and epidural air filling of cervical spine, head prone. The dorsal part of meninges is seen between two air-columns.

and a spinal tumour is that in the former there is only a narrowing of the epidural air column while in the latter there is an obstruction to the air column and accumulation of air below the tumour.

During and after the examination no pain will be experienced if the patient is kept lying down so that no air is allowed to reach the skull and cause headache. Most of the air will then escape into the paravertebral spaces where it does not cause pain.

The epidural spaces of the skull may also be filled with air, if required. The patient has then to be kept seated during the procedure. We have never used more than 20 ml of air for this purpose as we have feared that a greater quantity might cause rupture of the bridging veins.

The method has not been followed by any complications. Normal air myelography has probably a greater diagnostic value than epidural air filling, but in special cases the latter may be used alone or in combination with subarachnoidal air myelography and valuable additional information obtained.

SUMMARY

Experiences gained with epidural air filling of the spinal canal in a material of 20 cases, and the advantages of the method in comparison with normal air myelography and subarachnoidal air myelography, are briefly discussed.

ZUSAMMENFASSUNG

Die mit epiduraler Luftfüllung des Spinalkanales in 20 Fällen gewonnenen Erfahrungen und die Vorteile der Methode im Vergleich mit der normalen Luftmyelographie und der subarachnoidalen Luftmyelographie werden kurz besprochen.

RÉSUMÉ

L'auteur rapporte brièvement les résultats de son expérience d'injection d'air épidural dans le canal rachidien sur une série de 20 cas et examine les avantages de cette méthode par comparaison avec la myélographie gazeuse habituelle et la myélographie gazeuse sous-arachnoïdienne.

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FROM THE ROENTGEN DEPARTMENT OF THE NEUROLOGIC CLINIC (DIRECTOR: PROF. K. HENNER), CHARLES UNIVERSITY, PRAGUE, CZECHOSLOVAKIA

PNEUMOGRAPHIC INVESTIGATION OF THE CERVICAL SPINE

by

Jan Jirout

The employment of iodized oil compounds in the investigation of the spinal canal was introduced by SICARD and FORESTIER in 1922. The method was universally used for a considerable time and only during the last two decades has it been supplanted by one in which the employment of a negative contrast medium has been resumed. BEDRNA and VAVRDA (1937) first introduced spinal pneumography into Czechoslovakia.

Spinal pneumography has been used in our Department since the beginning of 1952, oil myelography being confined to those infrequent cases in which air produces no conclusive results, for instance in the upper thoracic region in obese patients. In the cervical spine, however, we have invariably been most satisfied with pneumography. Moreover, the advantages of air, as compared with oil myelography are many. As it is quickly resorbed, it is harmless and causes no reaction in the leptomeninges. The spinal cord and spinal canal to a greater extent are clearly outlined than with the mobile and often broken column of oil which moreover tends to form droplets.

If an upper cervical lesion is suspected cisternal puncture is contraindicated and the oil has to be conveyed, not without difficulty, from the lumbar region to the upper cervical region. The oil is often dispersed and may inadvertently enter the intracranial cavity. Nor has the technique of air filling of this region been satisfactorily solved.

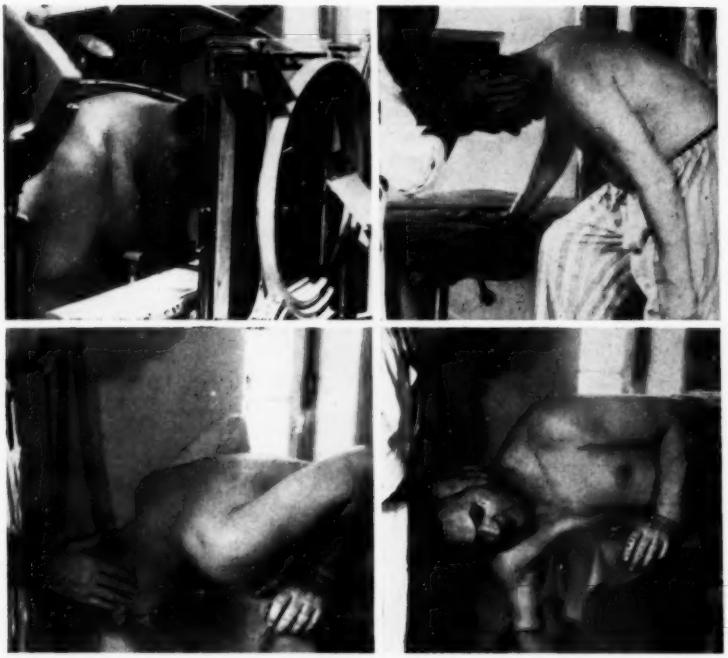

Fig. 1. *Upper views:* Positioning of patient during the insufflation (left) and patient placed on table with the head held lower than the cervical spine (right). *Lower views:* Prone positioning with the head still lowered (left), and patient turned to the supine position (right).

After a lumbar or cisternal puncture the patient is placed on a tilting table with the pelvis raised and head lowered. It is obvious that in this position the air will tend to flow upwards to the lumbar spine and much air will be needed to fill the cervical spinal canal (120 ml or more). Even so, air frequently enters the skull and causes headache, which is particularly troublesome in the aged who badly tolerate any lowering of the head.

Odén (1953) recommended air filling of the entire spinal canal by suboccipital puncture after complete evacuation of fluid up to the level of the needle, *i. e.* caudad of the puncture. This method is also impracticable whenever cisternal puncture is contra-indicated. Hence, the reasons why pneumography is not used more frequently are technical inconveniences. Only quite recently Murtagh et coll. published their method of manoeuvring a 40 to 50 ml air 'bubble' from the lumbar to the cervical region; this appears to be more satisfactory, although they also admitted failures in 12 out of 59 examinations.

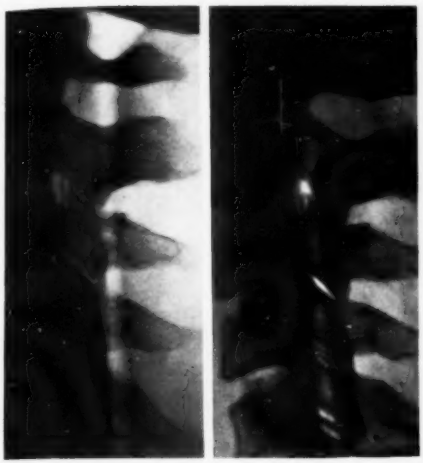

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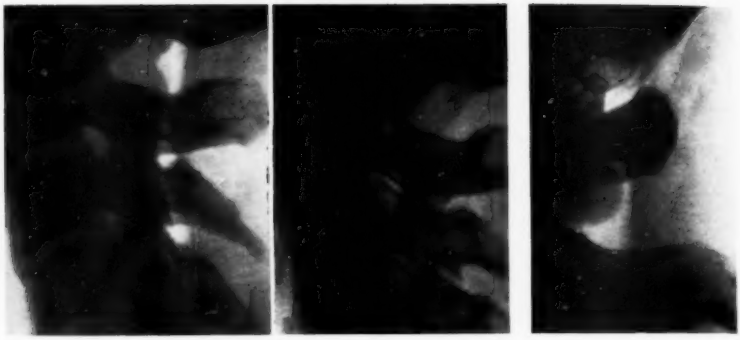
Fig. 2. a) Anteflexion. Posterior subarachnoid space of normal width. b) Supine. Protrusion of C3—4 and C6—7 discs into a normal anterior subarachnoid space.

We have therefore since 1952 used our own method. The patient is placed in the sitting position with maximum anteflexion of the head, so as to make the cervical spine the highest section of the cerebrospinal fluid pathways. Twenty to 30 ml of air introduced after lumbar puncture clearly delineate the dorsal aspect of the spinal cord and the posterior wall of the spinal canal in the lateral view. The spinal part of the cerebellomedullary cistern and its continuation into the cranial part are also shown. Narrowing or obliteration of the dorsal subarachnoid space in cases of tumour, syringomyelia, and even of arachnoidal adhesions, are well outlined in this view. Narrowing of the spinal part of the great cistern in the basilar impression, in the Arnold-Chiari deformity, and in cases of tumour of the posterior fossa with herniation of the cerebellar tonsils, and partial or complete block of the fluid pathways, may also be shown.

In many instances, however, it is necessary to obtain information about the ventral aspect of the spinal cord and the anterior wall of the spinal canal. The air must then be transferred into the anterior part of the subarachnoid space. This is achieved by the following manoeuvre.

The patient gets up and climbs or is lifted onto the table with his head held in anteflexion and lower than the cervical spine. He is then placed in the prone position with his head hanging over the edge of the table, and is turned into the supine position, the position of the head being maintained. The head is now somewhat lowered and retroflexed and the first film obtained (Fig. 1). The ventral aspect of the spinal cord and the anterior wall of the spinal canal will be clearly outlined, and enable the diagnosis of disc protrusions to be made. If during the manoeuvre the air escapes to the thoracic region it is easily returned to the cervical canal by slightly lifting the patient's shoulders. Should the filling prove insufficient the whole ventral aspect of the canal can still be shown by obtaining films with the head held successively in different positions from retroflexion to the horizontal.



a b c

Fig. 3.

a) Anteflexion. Protrusion of cerebellar tonsils into spinal part of cerebellomedullary cistern.

b) Supine. Normal width of anterior subarachnoid space at level of axis showing that the lesion is not a tumour.
Both are cases of Arnold-Chiari deformity.

c) Venous angioma on posterior surface of cervical spinal cord. One of the dilated veins is bulging into the enlarged posterior subarachnoid space between atlas and axis.

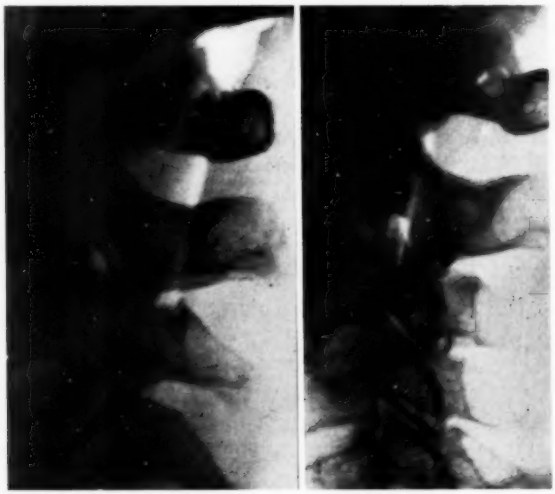


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Fig. 4. Ependymoma of the cervical and dorsal spinal cord (verified at operation). a) Anteflexion. Narrowing of posterior subarachnoid space at level of and below axis. b) Supine. Narrowing and obliteration of anterior subarachnoid space from level of C3 downwards.

It is the filling of both the anterior and posterior subarachnoid spaces that makes the differential diagnosis between a neoplasm and the Arnold-Chiari deformity possible. It also enables a diagnostic evaluation of the natural motility of the spinal cord in different positions of the spine (Figs. 2 to 4).

This method of investigation of the cervical spinal canal appears to be a valuable one. It is simple to perform and practically without danger to the patient.

SUMMARY

The author describes a method of pneumographic investigation of the cervical spine which has been employed since 1952 with excellent results. It is simple to perform and absolutely safe.

ZUSAMMENFASSUNG

Der Verfasser beschreibt eine Methode zur pheumographischen Untersuchung des zervikalen Rückenmarks, die seit 1952 mit ausgezeichneten Resultaten benutzt worden ist. Die Methode ist einfach in der Durchführung und ohne Gefahr.

RÉSUMÉ

L'auteur décrit une méthode d'examen pneumographique de la colonne cervicale, qui a été utilisée depuis 1952 avec d'excellents résultats. Elle est d'exécution simple et pas dangereuse.

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SLIGHT MYELOGRAPHIC DEFORMITIES IN SCIATICA

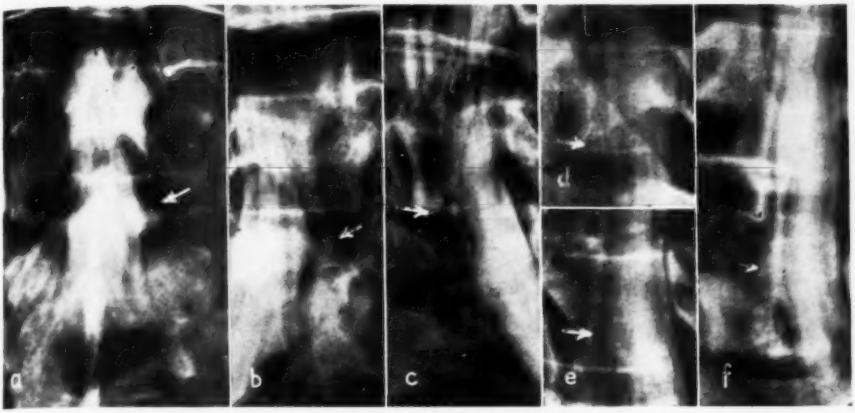
by

L. Walk

Slight myelographic deformities are found in most cases of sciatica even in those in which there is no protrusion to be operated upon. The relation of these deformities to various types of intervertebral disk changes has not been described in the literature.

Our material comprises 143 cases examined by myelography with a water-soluble contrast medium and by diskography. The material may be classified into 4 groups according to the diskographic findings: A) Normal, B) Disk rupture, without or with only slight widening of the nucleus pulposus, C) Degenerated disk with a widened nucleus pulposus, and D) Degenerated disk with rupture.

The current opinion is that an intervertebral disk causes symptoms by compressing the nerve although surgical records often mention only diffuse swelling of the nerve root interpreted as neuritis. The relation of the swelling of the nerve root to various types of disk changes has not been investigated in detail by methods available before diskography came into use. Swelling and compression have been mentioned in the literature, on myelography with water-soluble contrast media (STENSTRÖM), but they have not been dealt with separately and systematically. Our material reveals that swelling and compression may in many cases be considered separately.



Slight myelographic nerve root deformities in sciatica without protrusion (cases examined by diskography). a) and b) Diffuse swelling of L5-S1 root (arrow) in disk rupture of group B. Minimal deformity of L4-5 root pocket (arrow) in old, symptomless rupture of group B; a year ago, sciatica with sensibility changes at this segment. c), d), and e) Conical widening of nerve root in degenerated disk (group C), at level of disk or extending above; the latter a borderline case of conical and mixed deformity. Absence of protrusion in extreme flattening (d) verified at operation. f) Deformity of mixed type (group D).

In disk rupture (group B) the nerve root is usually thickened diffusely for a distance of 2 to 3 cm or more in the first few months as shown in (a) and (b) in the illustration. The root pocket may be filled with less contrast medium than normal. There is no marked displacement of the root. This myelographic deformity is explained by swelling of the nerve root caused by the perineural spread of the contents of the nucleus pulposus escaping through a disk rupture. After clinical recovery the myelogram is normal or there is a minimal deformity of the root pocket and of the nerve (a).

In degenerated disk (group C) most cases show a conical widening of the root localized to the level of the disk (c and d). The root pocket may be shortened. The conical deformity is explained by flattening of the nerve by pressure of the disk. It is found at all stages of the condition, even in long-standing cases. In addition to the conical flattening there may be a variable degree of swelling of the adjacent part of the nerve root; this myelographic deformity may be described as being of the mixed type (f). The separation of conical and mixed deformities may often be a subjective matter.

The myelogram in the diskographic groups is analysed in the following Table. In disk rupture (group B), diffuse swelling is frequent, especially in the first 4 months of the condition; later the nerve root may frequently be normal. Mixed deformities and other slight changes are occasionally found. In degenerated disk (group C) conical widening is most frequent, followed

Table

Slight myelographic nerve root deformities in sciatica without protrusion
Analysis of 143 cases examined by diskography

Diskography, group	No. of cases	Myelography: Normal	Diffuse swelling	Conical flattening	Mixed type	Other deformities: angulated or tortuous nerve roots in absence of thickening
A	4	1	—	—	2	1
B	21	6	10	—	3	2
C	51	3	2	28	15	3
D	67	5	11	22	23	6

by the mixed type; diffuse swelling is occasionally encountered. Rupture of a degenerated disk (group D) reveals a combination of the features of (B) and (C). In 4 cases of normal disk (group A) root deformities were present in 3, all in the L5 to S1 segment. The case with the normal root was probably a mixed one, the myelogram revealing a slight root deformity at another segment not examined by diskography. Arthrosis of the intervertebral joints was noted in 2 cases, both with marked scoliosis of the lower part of the lumbar spine, and spondylolisthesis in 1 case.

These slight myelographic deformities may render it possible to localize the disk producing the clinical signs. The presence or absence of nerve root swelling may be an indication that a rupture demonstrated by diskography is of recent date or is old. In typical diffuse or conical deformity the nature of the disk lesion may be inferred from the myelogram. In multiple disk changes the type and degree of the myelographic root changes may be used in the clinical evaluation of a case. Sciatica caused by factors other than disk lesions may be identified by the presence of myelographic root deformities with a normal diskogram.

The clinical findings are in keeping with the type of the myelographic root changes. In diffuse swelling, pain on coughing is frequent but numbness absent; even in the 2 cases of group C in which pain was present there was no numbness. Reflex, extensor, and sensibility changes are occasionally found. In conical flattening of the root, numbness is frequent, and reflex, extensor, and sensibility changes are much more frequent than in diffuse swelling. In deformities of the mixed type, the clinical findings are about the same as in conical flattening. The other root deformities have a clinical picture varying from case to case but reflex, extensor, and sensibility changes are found only in some cases. When the nerve root is normal most disks seem to have old symptomless ruptures; in two-thirds of the cases myelographic root changes are found at the level of some disks not examined by diskography, indicating a mixed case. Reflex, extensor, and sensibility changes are usually absent with a normal nerve root.

SUMMARY

In sciatica without disk protrusion, myelography may reveal two types of nerve root deformities: diffuse swelling of the nerve root, and conical flattening of the root by compression by the disk. Deformities of a mixed type are found in many cases. These myelographic deformities are in keeping with the clinical findings.

ZUSAMMENFASSUNG

Bei Ischias, in Fällen ohne Bandscheibenprolaps, können sich im Myelogram zwei Formen von Wurzelveränderungen finden: diffuse Anschwellung der Wurzel, und konische Verbreiterung der Wurzel welche durch die Bandscheibe plattgedrückt ist. Wurzeldeformitäten gemischter Form sind häufig. Diese myelographischen Veränderungen gehen parallel zu den klinischen Befunden.

RÉSUMÉ

Dans les sciatiques sans protrusion, la myélographie peut montrer deux types de déformation radiculaire: gonflement diffus de la racine, et élargissement conique de la racine aplatie par la compression du disque intervertébral. Les déformations du type mixte sont fréquentes. Ces changements radiculaires sont parallèles aux symptômes cliniques.

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SERVICE DE RADIOLOGIE ET SERVICE DE NEUROCHIRURGIE DE L'INSTITUT NEUROLOGIQUE DE MILAN, ITALIE

CAUSES RARES D'ÉLARGISSEMENT DU CANAL RACHIDIEN

par

G. Lombardi et *G. Morello*

Le but de ce bref exposé est de présenter quelques cas rares de lésions expansives intrarachidiennes dans lesquelles la symptomatologie provoquée par la compression de la moelle est accompagnée par un élargissement pathologique du canal rachidien.

L'importance de cette constatation radiologique est tellement connue qu'elle se passe de commentaires. Ce sont surtout les tumeurs bien délimitées, à développement lent, qui, exerçant une pression continue sur la colonne, finissent par laisser une empreinte sur les pédicules, les lames et sur la face postérieure des corps vertébraux. C'est justement à cause de leur fréquence que, pratiquement, on attribue aux néoplasmes tous les élargissements pathologiques du canal rachidien. Mais en réalité, n'importe quel processus pathologique qui exerce une pression continue et localisée finit toujours par provoquer des lésions vertébrales identiques aux lésions provoquées par les tumeurs. Parmi les causes d'élargissement du canal il y en a d'absolument imprévisibles, qui constituent souvent une véritable surprise au moment de l'opération.

Certains cas parmi les 7 suivants appartiennent à ce groupe. Ces cas ont été observés au cours de ces dernières années à l'Institut Neurologique de Milan.

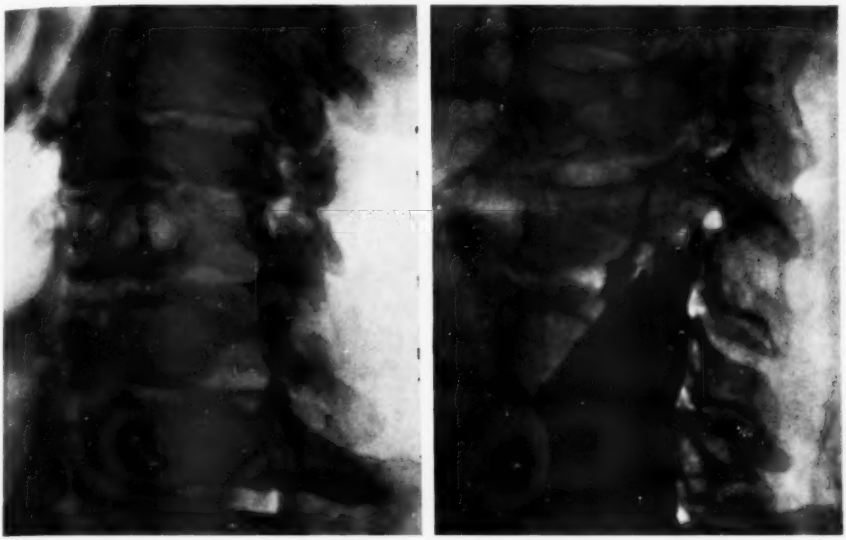


Fig. 1. Cas 1. Érosion des pédicules et des corps vertébraux de C4 à C6. (Chordome.)

Cas 1. G. A. (18.175). Homme de 69 ans. Depuis un an, parésie progressive du membre supérieur droit, puis des membres inférieurs. Parésie hypotonique du membre supérieur droit et parésie hypertonique des membres inférieurs, plus grave à droite. Hypoesthésie de C2 à C8 à droite et de C4 à C8 à gauche. Troubles de la miction.

Examen radiologique: Élargissement du canal rachidien avec érosion des pédicules et des corps vertébraux de C4 à C6. *Myélographie:* arrêt au niveau de C6 (Fig. 1).

Intervention: Tumeur extradurale située en avant de la moelle et adhérant aux corps vertébraux, étendue de C4 à C6. Examen histologique: chordome.

Cas 2. C. O. (15.956). Petite fille de 12 ans. Depuis cinq mois cyphose dorsale et douleurs épigastriques en ceinture; depuis dix jours paraparésie. Gibbosité dorsale inférieure. Grave paraparésie spastique.

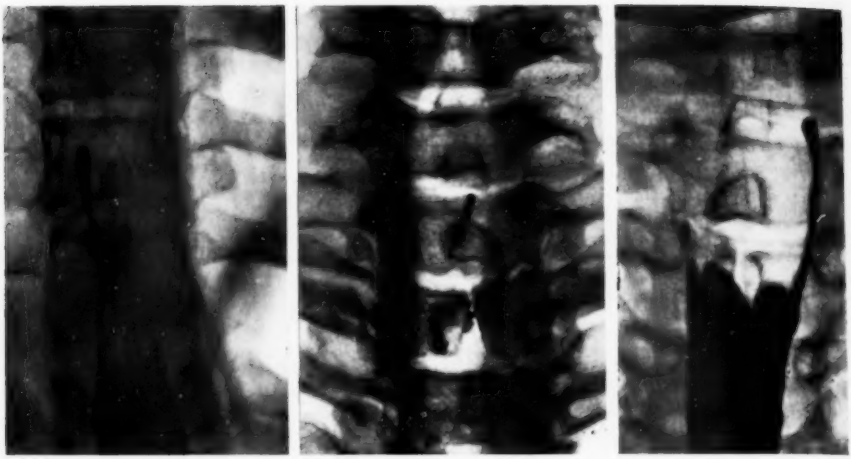
Examen radiologique: Érosion et dislocation des pédicules et des lames de D10. Arrêt lipiodolé au niveau de D9 à droite et de D10 à gauche (Fig. 2 a).

Intervention: laminectomie de D9, D10 et D11; lames et pédicules infiltrés par un tissue de couleur brune; le même tissu enveloppe le sac dural et les gaines radiculaires Examen histologique: tumeur à myéloplaxes.

Cas 3. R. B. (20.649). Femme de 35 ans. Depuis deux ans troubles sphinctériens à type d'incontinence; depuis un an et demi parésie des muscles fléchisseurs dorsaux du pied gauche. Paralysie des muscles fléchisseurs dorsaux du pied gauche. Hypoesthésie dans le territoire de S3 à S5. Aréflexie achilléenne et plantaire.

Examen radiologique: Élargissement du canal rachidien avec érosion des pédicules de D11, D12 et L1; la face postérieure de ces corps vertébraux est concave. *Myélographie:* arrêt en dôme en L1.

Intervention: lipome du cône terminal.



a b c

Fig. 2. a) Cas 2. Érosion et dislocation des pédicules et des lames de D10. (Tumeur à myéloplaxes.) b) et c) Cas 4. Augmentation de la distance interpédiculaire de D1; spina bifida de D 2. (Tumeur dermoïde intramédullaire.)

Cas 4. C. G. (20.146). Homme de 19 ans. Depuis un an, diminution progressive de force au membre inférieur droit. Parésie hypertonique du membre inférieur droit; hypoesthésie de D1 en bas à droite et hypopallesthésie de D1 à D10 à gauche; Babinski bilatéral.

Examen radiologique: Augmentation de la distance interpédiculaire de D1; spina bifida de D2. *Myélographie:* arrêt en D2 (Fig. 2, a et b).

Intervention: tumeur dermoïde intramédullaire à la hauteur de D1 à D2.

Cas 5. T. S. (23.841). Petit garçon de 10 ans. Depuis 15 jours paraparésie progressive des membres inférieurs. Paraparésie spastique des membres inférieurs; hypoesthésie de D6 jusqu'en bas.

Examen radiologique: Élargissement du canal rachidien avec érosion des pédicules droits de D6 et D7. *Myélographie:* arrêt à la hauteur du disque D6—D7, avec refoulement de la colonne opaque par une lésion extradurale gauche (Fig. 3 a).

Intervention: le sac dural est comprimé et déplacé vers la droite par une volumineuse hernie du disque D6—D7.

Cas 6. R. F. (14.036). Garçon de 15 ans. Depuis la naissance, hypotrophie du membre inférieur gauche avec genu valgum et pied bot. Depuis deux mois, diminution progressive de la force et de la sensibilité des membres inférieurs. Hypotrophie musculaire difffuse; paraparésie spastique des membres inférieurs; hypoesthésie de D8 à D12; Babinski bilatéral.

Examen radiologique: Élargissement du canal rachidien avec érosion et aplatissement des pédicules de D8 et D9; érosion du pédicule droit de D11. *Myélographie:* après arrêt passager en D9, l'huile iodée pénètre dans un gros kyste qui s'étend de D7 à D9 et dans un deuxième kyste niché dans le pédicule droit érodé de D11.

a b c

Fig. 3. Cas 5. Érosion des pédicules droits de D 6 et D 7. (Hernie du disque.) b) et c) Cas 7. Anévrismes multiples intraduraux avec élargissement du canal rachidien.

Intervention: deux kystes arachnoïdiens extraduraux communiquant avec les espaces sous-arachnoïdiens; l'un s'étend de D7 à D9 et l'autre, plus petit, s'insère sur la gaine de la onzième racine dorsale droite.

Cas 7. G. S. (11.747). Homme de 22 ans. Depuis la naissance, hypotrophie du membre inférieur gauche, devenu ensuite oedémateux et éléphantiasique. A 16 ans, affection douloureuse des membres inférieurs qui fut diagnostiquée polynévrite. Depuis quelques mois, troubles sphinctériens à type d'incontinence. Scoliose lombaire convexe à droite. Oedème et cyanose du membre inférieur gauche. Hypoesthésie dans les 2me et 3me dermatomères lombaires des deux côtés; hyporéflexie des membres inférieurs.

Examen radiologique: Les pédicules gauches de D11 et D12 sont aplatis et ceux de droite sont détruits. Aspect concave des faces postérieures de ces mêmes corps vertébraux. *Myélographie:* double arrêt en dôme en D12 et en L2 (Fig. 3 c).

Intervention: laminectomie de D12, L1 et L2; à l'intérieur du sac dural deux anévrysmes artériels, l'un à la hauteur de L1 et l'autre à la hauteur de L2.

Les conclusions qu'on peut tirer de ce bref exposé sont les suivantes: les causes d'élargissement du canal rachidien sont bien plus nombreuses qu'on ne le croit d'habitude, et il est presque impossible d'établir la nature de la lésion avec les seuls renseignements fournis par l'examen radiologique standard. Les images lipiodolées elles-mêmes ne suffisent pas à établir un diagnostic pré-opératoire précis. En effet, dans nos cas, cela n'a été possible qu'une seule fois (Cas 6).

RÉSUMÉ

Les auteurs soulignent que les causes d'élargissement du canal rachidien sont bien plus nombreuses qu'on ne le croit habituellement. La radiographie simple et même la myélographie lipiodolée ne permettent en général pas le diagnostic pré-opératoire précis de la nature de la lésion. Ils présentent 7 cas de lésions expansives intrarachidiennes rares où le diagnostic de nature n'a été possible qu'une fois.

SUMMARY

The causes of widening of the spinal canal are much more numerous than usually believed. Conventional roentgenography and even myelography with Lipiodol do not generally provide an accurate pre-operative diagnosis of the nature of the lesion. Seven cases of expansive lesions of the spinal canal are reported in only one of which could the type of lesion be diagnosed.

ZUSAMMENFASSUNG

Es wird betont, dass Erkrankungen, die mit einer Erweiterung des Spinalkanales verlaufen, viel häufiger vorkommen als man gewöhnlich annimmt. Konventionelle Röntgenuntersuchungen und auch die Myelographie mit Lipiodol ermöglichen nicht immer die genaue präoperative Diagnose der Art der Erkrankung. Sieben Fälle mit ungewöhnlichen expansiven Veränderungen im Spinalkanal werden berichtet. Die Art der Erkrankung konnte nur in einem Falle diagnostiziert werden.

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ROENTGENOLOGIC CHANGES IN CEREBRAL SARCOIDOSIS

by

Georg-Fredrik Saltzman

Signs of involvement of the nervous system in cases of sarcoidosis are recognized. Although their occurrence is infrequent, more than a hundred such cases have been described in the literature; roentgenologic investigations, have, however, rarely been carried out and an expanding cerebral process has only in a few cases been found to be the cause of the signs. Two such cases from our hospital have been described by HÖÖK and by LINDGREN; these are included in my material. UEHLINGER found a tumour at the base of the cerebrum, EVERTS a large occipital tumour, and SKILLICORN and GARRITY a tumour in the middle fossa, all of which proved to be sarcoid granulomas. Our material now consists of five cases with intracranial expanding processes, obviously granulomas of a sarcoid nature.

Case 1. (Fig. 1.) Male, aged 23, who in 1950 was found to have lung changes characteristic of sarcoidosis. Two years later he developed right-sided haemianopsia associated with mental sluggishness. Biopsy of an enlarged lymph node indicated sarcoidosis. The Mantoux reaction was negative. A total of 5 million units of penicillin was given over 10 days and the haemianopsia gradually regressed.

Encephalography was performed both before and after treatment, the interval between the examinations being two months. At the examination prior to treatment the anterior part of the ventricular system was displaced to the right and the left frontal horn was displaced backwards. There was thus a frontal expanding process on the left side.

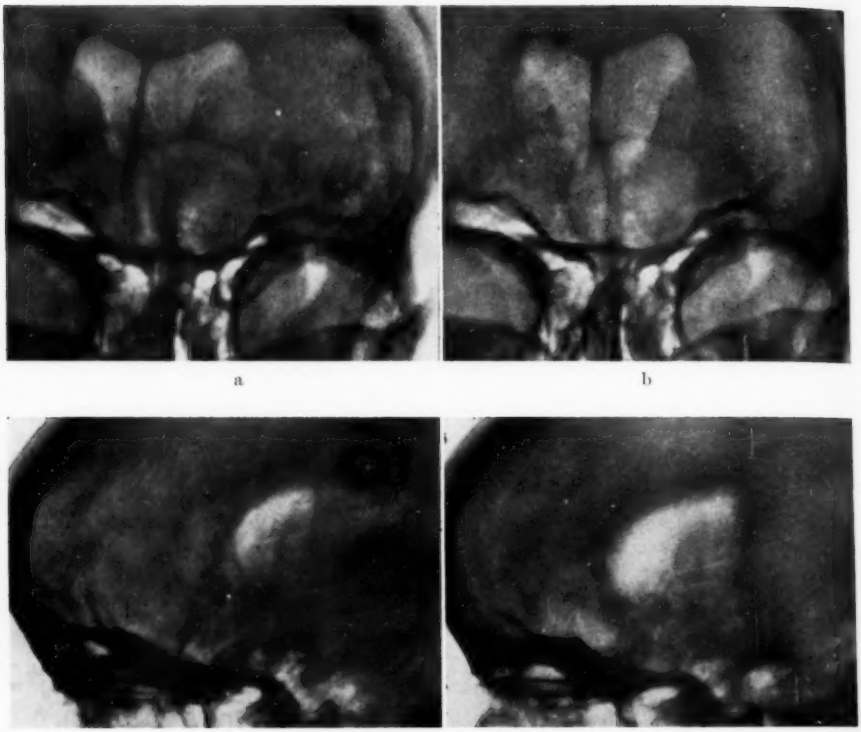

Fig. 1. Case 1. a) and c) Before treatment: ventricular system displaced 1 cm to the right; left frontal horn moved backwards. b) and d) After treatment: ventricular system now normal in position but slight widening of the left lateral ventricle including temporal horn has developed.

Carotid angiography performed at the same time showed that the process was poorly vascularized.

Two months later the displacement of the ventricular system had disappeared but a slight widening of the left lateral ventricle, including the temporal horn, had developed.

A follow-up examination one year later showed the patient to be completely free from symptoms and signs.

Case 2. (Figs. 2 and 3.) Male, aged 26, who in 1954 began to suffer from severe headache. During the following year he gradually became mentally sluggish and had several epileptic fits. There was generalized enlargement of the lymph nodes, a biopsy of one of which indicated sarcoidosis. The patient was treated with large doses of cortisone. His psychic state rapidly improved but a few months later he again had several epileptic fits. Since then his condition has remained stationary; he has had no fits but his mind is sluggish and he suffers from some weakness in the legs.

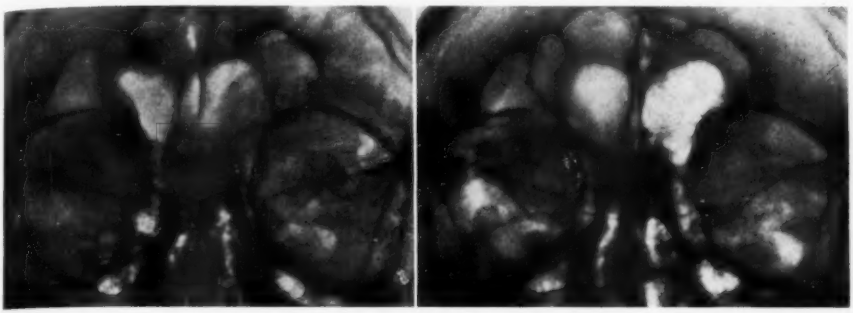

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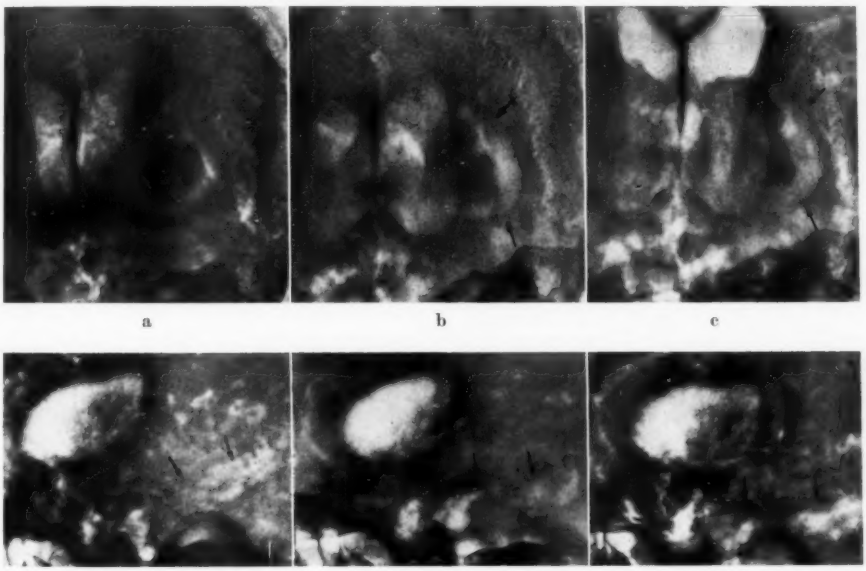
Fig. 2. Case 2. a) Before treatment: ventricular system moderately displaced to the right. b) One year after treatment: the displacement has almost disappeared but the entire ventricular system is somewhat dilated.



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d e f

Fig. 3. Case 2 (See also fig. 2). a) Before treatment: left temporal horn deformed both medially and laterally. b) One year after treatment: temporal horn still irregular. c) Six months later: temporal horn filled more easily and now wider than at previous examinations, although still deformed. d), e), and f) Lateral views from three examinations. Temporal horn irregular and compressed just behind its knee.

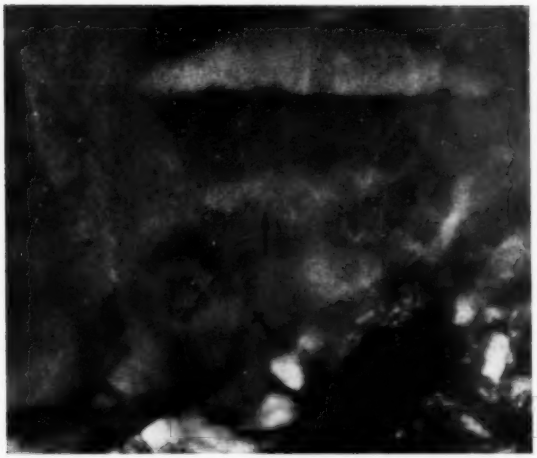

Fig. 4. Case 3. Suprasellar mass bulging into bottom of third ventricle (→). Intrapeduncular cistern compressed from above (↔). The sella changes indicate increased pressure.

At *encephalography* before treatment the ventricular system was displaced to the right and the left temporal horn was deformed both from the medial and lateral aspects at the level of the knee with irregular indentations indicating an intracerebral expanding lesion in the temporal region.

Two encephalographic examinations after treatment showed that the ventricular displacement had practically disappeared. The temporal horn was wider than at the first examination but still showed irregular indentations. The entire ventricular system was somewhat dilated.

Case 3. (Fig. 4.) Female, aged 36, who in 1951 developed signs of a bronchial infection together with enlarged lymph nodes and multiple skin infiltrations; biopsy revealed sarcoidosis. Three years later the patient developed persistent headache and was found to have choked disks.

Encephalography disclosed a suprasellar mass bulging into the bottom of the third ventricle and the interpeduncular cistern was compressed from above. The sella turcica showed signs of increased intracranial pressure.

The patient was operated upon and large portions of the tumour were removed. Sarcoidosis was confirmed histologically. The patient died shortly afterwards.

Case 4. Male, aged 49, who in 1949 developed marked psychic changes. About a month later the lymph nodes were found to be generally enlarged and sarcoidosis was demonstrated by biopsy. A year later he had left-sided haemiplegia.

Carotid angiography showed a poorly vascularized expanding lesion in the right temporal region. Operation revealed a large intraventricular mass in the right temporal horn, which appeared to emanate from the choroid plexus; it was removed as far as was possible.

Histologic examination showed sarcoidosis. Two years later the patient was well and had returned to work. Enlarged lymph nodes were still present.

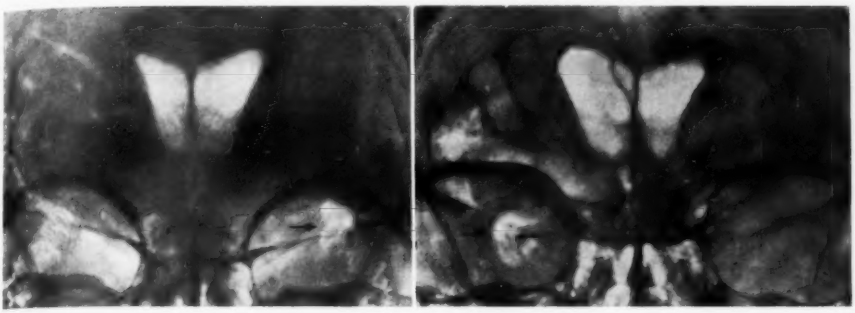

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Fig. 5. Encephalograms from three cases of sarcoidosis without demonstrable expanding processes. a) Dilatation of left lateral ventricle as well as temporal horn. b) Dilatation of right lateral ventricle without widening of temporal horn. c) Dilatation of right lateral ventricle including temporal horn.

Case 5. Male, aged 16, who in a period of six weeks developed increased intracranial pressure with evidence of choked disks.

Pneumography revealed a large tumour in the pineal region with extreme hydrocephalus; many small calcifications were noted within the tumour.

The patient was operated upon and part of the tumour removed. Histologic examination indicated sarcoidosis.

The patient lived on without symptoms for a further 17 years and died after a traffic accident. Sarcoidosis was never demonstrated in any other organs in this case.

Discussion

In these five cases of probable sarcoid granulomas the situation of the lesion varied but the appearances were the same as those produced by other forms of expanding processes. In the two cases in which angiography was performed the lesions were shown to be poorly vascularized. The lesions decreased with purely conservative treatment and local atrophy gradually developed in the two cases in which the development of the

cerebral changes was followed. There was no recurrence in the two cases which survived operation in spite of the fact that at least in one the operation was not completely radical.

In order to shed additional light on the question of the development and prognosis of cerebral sarcoid granulomas, I have examined all the encephalograms obtained at our hospital in cases of verified sarcoidosis. Three cases were found to have intracerebral changes (Fig. 5).

In the first case encephalography performed three years after the appearance of neurologic changes showed the left lateral ventricle as well as the temporal horn to be somewhat dilated. In the second case with left-sided haemianopsia of unknown duration, encephalography showed dilatation of the right lateral ventricle; in this case the temporal horn was, however, not dilated. In the third case encephalography, performed nine years after the occurrence of left-sided haemiplegia and haemianopsia, revealed dilatation of the right lateral ventricle including the temporal horn. Thus in three verified cases of sarcoidosis with neurologic symptoms and signs of varying duration we have found cerebral atrophy of different degrees and at various sites. The two cases discussed earlier in which the pneumography was repeated showed that when the expanding lesion had disappeared it was followed by atrophy. It therefore seems possible that the atrophy in these three latter cases was the end-result of cerebral sarcoidosis.

In conclusion it may be stated that sarcoidosis may cause intracranial granulomas. They appear as poorly vascularized expanding lesions in various situations, in most cases with evidence of sarcoidosis in other organs. In those of our cases which have received conservative treatment the granulomas have decreased considerably in size or completely disappeared and atrophy has developed at their site. It therefore appears that the treatment of known cases of sarcoidosis should primarily be conservative.

SUMMARY

In a material of verified sarcoidosis 8 cases were found to have had intracerebral changes. Five of these are reported in detail with special reference to the pneumographic appearances.

ZUSAMMENFASSUNG

Acht Fälle eines Materiales mit verifizierter Sarkoidosis hatten intracerebrale Veränderungen gehabt. Fünf dieser Fälle werden eingehend unter besonderer Bezugnahme auf das pneumographische Aussehen geschildert.

RÉSUMÉ

Sur une série de cas de sarcoïdose vérifiée, huit présentaient des lésions intracérébrales. L'auteur en décrit en détail cinq cas et insiste particulièrement sur les images pneumo-encéphalographiques.

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CONTRIBUTION À L'ÉTUDE RADIOLOGIQUE DES MALFORMATIONS DU PLAN SAGITTAL INTERHÉMISPHÉRIQUE À PROPOS DE 45 OBSERVATIONS

par

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Au cours de 1.349 études encéphalo-pneumographiques, pratiquées chez l'enfant depuis novembre 1953, nous avons relevé 45 cas de malformations du plan sagittal interhémisphérique. Nous réunissons sous ce terme les absences totales de septum lucidum réalisant un ventricule unique, les agénésies totales ou partielles du corps calleux, les kystes du septum lucidum, les cavum du septum lucidum et les cavum de Verga, enfin la citerne interventriculaire qui, longtemps confondue avec le cavum de Verga, en est bien différente du point de vue anatomique.

Nous ne citerons ici que les travaux de REIL en 1812 qui donna la première description de ces malformations, puis ceux de MINGAZZINI (1922) et THOMAS (1929). C'est à DAVIDOFF et DYKE (1934) que revient le mérite d'avoir donné la première description complète des images pneumographiques de ces diverses malformations.

Rappel embryologique. Les éléments commissuraux médians ont leur origine dans l'ébauche commissurale située à la face interne de l'hémisphère et apparue dès la septième semaine. Ils ne se différencient que

vers la dixième ou douzième semaine. Au quatrième mois, le corps calleux, le septum lucidum, le trigone sont constitués.

On explique ainsi la détermination, au début de la vie embryonnaire, d'anomalies grossières réalisant une absence totale de septum lucidum, une agénésie totale ou partielle du corps calleux, un cavum du septum lucidum, avec ou sans expansion caudale (cavum de Verga).

La citerne interventriculaire par contre est une anomalie anatomique du système cisternal. C'est une cavité qui fait suite à la citerne de la veine de Galien; elle se situe entre le trigone en haut, le toit du troisième ventricule en bas (elle en est séparée par la toile choroïdienne supérieure); elle se termine en s'effilant au niveau de la queue du septum lucidum et des piliers antérieurs du trigone. Virtuelle normalement, elle réalise dans quelques cas une cavité pathologique de taille variable.

Malformations associées. A la lumière de nombreuses vérifications anatomiques retrouvées dans la littérature, il est apparu que d'autre malformations y sont souvent associées: agénésie de la commissure de l'hippocampe, absence de fusion du pilier antérieur du trigone, agénésie de certaines zones cérébrales: polygyrie, microgyrie, brachygyrie, agyrie, absence de nerf olfactif, dysraphie septo-optique (dont nous avons observé récemment un cas personnel).

Matériel étudié

Clinique. Certains caractères communs permettent de penser au diagnostic de malformation de la ligne médiane avant toute exploration radiologique. Mais seule cette dernière peut confirmer le diagnostic et préciser le type de la lésion en cause.

Circonstances étiologiques. Bien que nous ayons observé 30 garçons pour 15 filles, nous n'oserions affirmer une incidence particulière en fonction du sexe.

Les signes révélateurs ont amené 25 de nos malades à l'examen radiologique avant l'âge d'un an (soit 55 %). Les malades présentant des citernes interventriculaires étaient particulièrement jeunes: sur 13 cas 11 n'avaient pas 1 an, 8 n'avaient pas 6 mois.

Contrairement à certaines publications françaises ou étrangères antérieures, nous n'avons retrouvé que très exceptionnellement des infections lors de la grossesse. Sur nos 45 cas, nous n'avons noté que 4 cas de toxoplasmose authentique. Par contre, 8 anoxies de la naissance (soit 22 %) ont été observées sans que nous puissions préciser leurs rapports exacts avec la malformation.

Signes révélateurs. Nos constatations sont sensiblement les mêmes que celles que nous avons relevées dans la littérature: 32 crises convulsives soit 71 % (54 à 88 % pour d'autres auteurs), 36 retards psychomoteurs (dont 29 cas associés à des crises convulsives) soit 80 %, (31 à 82 % pour d'autres auteurs). Le type même des crises nous a cependant paru évocateur dans certains cas; huit fois (soit 17.7 %) ces crises étaient toniques antérieures ou postérieures; une telle proportion n'a jamais été signalée à notre connaissance.

Peu de signes de localisation à l'examen: 9 hémiplégies, 5 quadriplégies (31 %), (57 % pour d'autres auteurs). Nous avons néanmoins observé des mouvements anormaux d'un type particulier (mouvement de brasse, d'ailes de papillon) dans 3 cas.

Malformations associées. Sept malades étaient microcéphales (soit 15.5 %), (6 % pour d'autres auteurs), 5 étaient hydrocéphales, 3 avaient une microphtalmie.

Examens complémentaires. Les données du fond d'oeil sont assez disparates: 19 fois il était normal (en particulier pour 9 citernes interventriculaires sur 13), quatre enfants avaient une atrophie optique, quatre autres des papilles pâles, un une stase papillaire, un une dégénérescence maculaire; enfin deux choiro-rétinites toxoplasmiques ont été observées. Quant à l'électroencéphalogramme, il nous a montré huit fois un tracé strictement normal, vingt et une fois un tracé altéré de façon diffuse.

En résumé la clinique permet parfois de songer au diagnostic sur l'association très précoce de crises convulsives et d'un retard psychomoteur grossier. S'il s'agit de crises toniques antérieures ou postérieures, s'il existe des mouvements anormaux du type spécial que nous avons signalé, ces malformations doivent être plus spécialement évoquées. En fait, c'est l'examen pneumographique (encéphalographie ou ventriculographie) qui confirme le diagnostic, révèle le type de la malformation.

Absence congénitale de septum lucidum (*ventricule unique*) (*12 cas*).

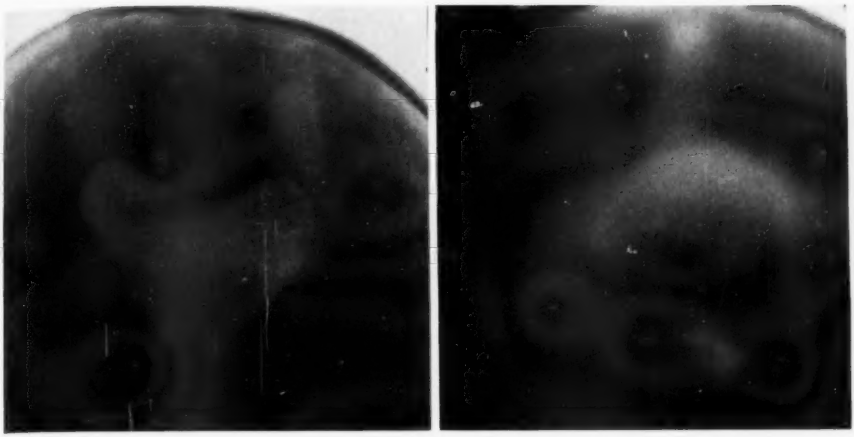
La malformation modifie essentiellement l'image ventriculaire. En effet le septum est absent et, à sa place, un large orifice de communication réunit la partie antérieure des corps et les cornes frontales des ventricules latéraux. Souvent même cet orifice est plus étendu que ce qui correspondrait à un septum normal. Cette anomalie est surtout visible sur les clichés (face et profil) réalisés en décubitus dorsal. De face apparaît un ventricule unique médian, large et symétrique, sans séparation septale, qui semble se continuer en bas avec le troisième ventricule. Mais de profil le toit du troisième ventricule est habituellement bien individualisé, du moins dans sa partie postérieure. La forme générale des ventricules latéraux est habituellement respectée: les cornes postérieures, carrefours et cornes temporales conservent leur aspect habituel, comme en témoigne toute la série des clichés.

Il est fréquent de découvrir, lors de la pneumographie, d'autres états pathologiques associés.

L'atrophie cérébrale est de règle, se traduisant par une dilatation ventriculaire importante sans être excessive et intéressant, tantôt seulement la région frontale, tantôt l'ensemble du système ventriculaire.

Très souvent également, nous observons un élargissement considérable des espaces sous-arachnoïdiens (citernes, sillons corticaux), tout ceci venant confirmer l'existence d'une atrophie cérébrale importante.

Cette image ne manquera pas de soulever un problème de diagnostic différentiel: nous savons combien il est fréquent de déceler des déchirures



a b

Fig. 1. a) Face en décubitus: ventricule unique médian, élargi, sans séparation septale. Porencéphalie interne pariétale gauche. b) Tomographie de profil. La brèche de communication interventriculaire. (Absence congénitale de septum lucidum avec ventricule unique. Retard psycho-moteur, hémiplégie droite.)

du septum au cours de l'hydrocéphalie. Nous avons éliminé de notre étude tous les cas où l'absence de septum s'observait en même temps qu'une extrême dilatation du système ventriculaire. Dans tous les autres cas, nous estimons, à la lumière des constatations opératoires faites sur les hydrocéphales, qu'une absence aussi complète de septum ne pourrait s'expliquer par un phénomène acquis de distension des ventricules.

Un autre problème reste à discuter: l'hydranencéphalie qui réalise un ventricule unique d'un type particulier, heureusement exceptionnel (nous n'en avons observé que quatre cas au cours de ces cinq dernières années). Une partie plus ou moins importante du cerveau est absente, remplacée par une cavité occupant la presque totalité de la boîte crânienne elle-même dilatée. Cette cavité, souvent asymétrique, ne laisse plus subsister que les élèments ganglionnaires du mésencéphale et parfois une portion limitée d'un des pôles hémisphériques. Dans tous ces cas, la morphologie du système ventriculaire supratentoriel a totalement disparu.

L'agénésie du corps calleux (8 cas)

L'étude des différentes séries de clichés de nos 8 malades ne permet que de confirmer le schéma radiologique donné par DAVIDOFF et DYKE dans leur traité.

a b

Fig. 2. a) Face: écartement des ventricules latéraux avec aspect typique en corne. (9 mois — Agénésie du corps calleux, retard psycho-moteur, hydrocéphalie, nystagmus.) b) Face en décubitus: aspect ovalaire du septum. (11 ans — Kyste du septum lucidum, crises temporales, retard psycho-moteur, stase papillaire.)

L'écartement des ventricules latéraux est certainement le signe le plus important. Il s'observe sur les clichés de face en décubitus dorsal. Il ne prête jamais à discussion car il est toujours important (en moyenne 1.5 centimètres); il est accompagné d'un deuxième signe: une incurvation, un enroulement des ventricules latéraux; ceux-ci s'infléchissent vers l'intérieur et ne présentent plus, comme normalement, au niveau du corps et des cornes frontales, une face interne, une face supérieure et une face externe. En effet, on voit seulement dans ces cas, d'une part une face interne concave en parenthèse (signe bien décrit par DAVIDOFF et DYKE que nous avons retrouvé fréquemment), d'autre part une face externe convexe: ces deux faces se réunissent vers le haut pour former un angle assez pointu. Cet aspect «en corne» des ventricules latéraux était considéré comme un signe très important par DAVIDOFF et DYKE.

En bas, les ventricules latéraux se continuent sans limites précises avec un troisième ventricule élargi. Cette absence de plancher ventriculaire est surtout nette dans la partie antérieure, car dans la partie postérieure, l'anatomie normale des ventricules latéraux se retrouve et le plancher, formé par le thalamus et le noyau caudé, y est bien dessiné.

Un signe par contre que nous avons fréquemment retrouvé, a été signalé également dans d'autres travaux: la dilatation du carrefour et des cornes postérieures (5 fois sur 7). Nous ne comptons pas les deux cas où les ventricules latéraux dans leur ensemble étaient très dilatés.

Le troisième ventricule s'ouvre aussi largement en Y dans les ventricules latéraux. Sur les clichés de profil, les trous de Monro sont très grands; ils ont souvent plus de 1 centimètre et cet agrandissement semble se faire aux dépens du toit du troisième ventricule. Sur les clichés, de profil également, le troisième ventricule se projette au dessus de la limite inférieure des corps des ventricules latéraux comme l'avaient bien montré DAVIDOFF et DYKE. L'agrandissement des trous de Monro et la projection du toit du troisième ventricule au-dessus de la limite ont été retrouvés respectivement dans 6 cas et dans 8 cas sur 8.

Un dernier symptôme a été décrit par ces auteurs: les images des sillons radiés de la face interne de l'hémisphère descendant au-dessous de la limite supérieure des ventricules latéraux sur les clichés de profil. Nous notons ce signe 4 fois sur 8 (3 fois sur 5 cas étudiés par encéphalographie et 1 fois sur 3 cas explorés par ventriculographie).

Ainsi donc, dans le schéma de DAVIDOFF et DYKE, nous retiendrons surtout l'aspect en corne et l'écartement des cornes frontales, l'élargissement des trous de Monro, la surélévation du toit du troisième ventricule par rapport aux ventricules latéraux.

Il nous paraît intéressant de noter également les états pathologiques associés: nous avons trouvé une dilatation des ventricules latéraux, témoin d'une atrophie cérébrale dans 2 cas et dans 1 cas une atrophie frontale localisée avec signes osseux d'hyperostose compensatrice en regard. L'étude des sillons corticaux révèle une atrophie corticale bilatérale dans 3 cas, unilatérale dans 1 cas. Les clichés sans préparation ne montrent habituellement rien d'anormal. Dans un cas de toxoplasmose où le diagnostic avait été porté sur une chorio-rétinite associée aux signes biologiques, nous n'avons pas constaté de calcifications intra-craniennes.

Kyste du septum — cavum du septum — cavum de verga (11 cas).

Nous décrivons sous le terme de cavum du septum les cas où nous trouvons, au sein d'un septum lucidum élargi, une cavité injectée par l'encéphalographie ou la ventriculographie; les parois en sont planes ou à peine bombées. Par contre, nous réservons le terme de kyste aux cas où le septum élargi, souvent de façon importante, à parois convexes, ne s'injecte pas lors des examens pneumographiques.

Le kyste du septum (*5 cas*) présente une image évidente sur les clichés de face en décubitus: les cornes frontales et les corps, dont la morphologie est habituellement conservée, sont séparés sur la ligne médiane par une bande opaque, large de 4 à 5 millimètres, parfois plus, à parois externes souvent plus ou moins convexes, régulières, symétriques ou très légèrement asymétriques, sans bosselure. Le troisième ventricule s'inscrit au-

Fig. 3. Profil en décubitus: cavum interventriculaire étendu très en arrière. Le cavum est comme toujours associé à un cavum du septum. Calcifications tapissant les parois du cavum. (4 ans — Cavum de Verga, retard psycho-moteur, crises convulsives, toxoplasmose.)

dessous de cette image sur le cliché de face. De profil, on devine souvent en tonalité, sur le cliché en décubitus dorsal, une plage faiblement opaque, à limites dégradées, dont la forme et la topographie correspondent exactement à celles du septum sur les coupes anatomiques. Cet aspect radiologique, tant de face que de profil, est suffisamment évocateur pour que l'on n'ait pas à discuter d'autres diagnostics.

En effet l'agénésie du corps calleux donne une image du même ordre en raison de l'espace qui sépare les faces internes de ventricules latéraux; mais, dans le kyste septal, le ventricule conserve sa morphologie générale et ne prend jamais l'aspect en parenthèse ou en corne, caractéristique de l'agénésie du corps calleux et le troisième ventricule reste nettement séparé des ventricules latéraux.

Les tumeurs du septum lucidum restent un diagnostic différentiel classique, mais elles sont d'une extrême rareté, en particulier chez l'enfant. Elles donnent classiquement un élargissement asymétrique du septum qui paraît souvent irrégulièrement bosselé. Nous avons observé une fois une image de ce type chez un enfant qui avait présenté une hémorragie cérébro-méningée; l'encéphalographie révélait un élargissement asymétrique du septum dû à la présence d'un caillot intra-ventriculaire plaqué contre l'une des faces.

Nous ne signalons que pour mémoire le faux aspect de kyste du septum que l'on peut observer sur les clichés en décubitus dorsal lorsque l'injection gazeuse est très faible et que seule se trouve injectée la partie

toute antérieure et divergente des cornes frontales. Le cliché de profil lève les doutes de façon formelle.

Nos cinq cas de kyste du septum lucidum ne prêtent pas à discussion et présentaient l'image caractéristique que nous venons de décrire. Il est intéressant de noter que l'un d'eux était associé à une atrophie corticale, un autre à une atrophie cérébrale frontale gauche traduite par une dilatation de la corne correspondante.

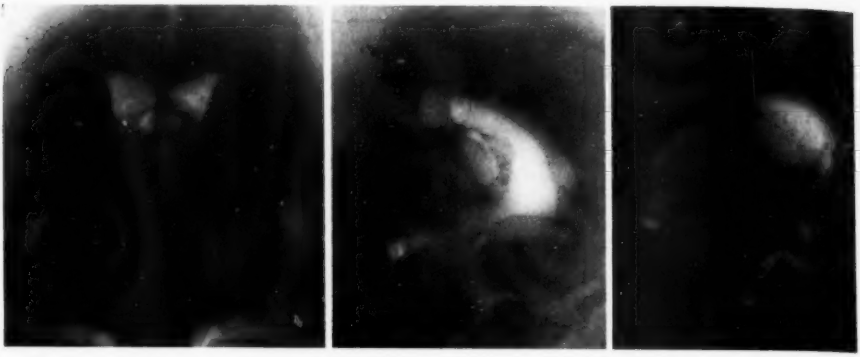
Cavum du septum — Cavum de Verga (*6 cas*). Leur image radiologique est stéréotypée. De face, en décubitus, entre les cornes frontales et les corps des ventricules latéraux dont la morphologie est respectée, s'inscrit une cavité injectée par le gaz, large de quelques millimètres à parois latérales rectilignes, ou à peine convexes. Le troisième ventricule se projette sous cette cavité médiane.

De profil, en décubitus, une plage plus transparente en tonalité, occupe la situation correspondant au septum. Sur le cliché en procubitus, il arrive souvent que ce cavum reste injecté.

Le cavum de Verga, cavité supplémentaire (6ème ventricule) occupe aussi une situation médiane. Il se loge en arrière du cavum du septum auquel il est toujours associé. Anatomiquement, il est situé sous le corps calleux entre lui et les fibres d'association transversales qui unissent les piliers postérieurs du trigone (lyre de David ou psaltérium). Son image radiologique est la suivante: de face, elle est trapézoïdale, à petite base supérieure très étroite, à grande base inférieure un peu convexe; elle se projette en superposition sur le cavum du septum et déborde en haut le plancher des ventricules latéraux, en bas, le toit du troisième ventricule; de profil, elle est en forme de virgule dont l'extrémité antérieure, effilée vient presque jusqu'aux trous de Monro et dont la grosse extrémité postérieure ne déborde pas en règle la limite postèrieure du toit du troisième ventricule. Notre statistique comporte 6 cavum du septum (dont 2 étaient associés à des cavum de Verga) qui répondent à la description ci-dessus.

La pneumographie a eu le mérite de nous révéler en outre d'autres signes associés: nous avons observé 3 grandes atrophies cérébrales bilatérales. Dans un de ces cas, en outre, il existait une importante injection gazeuse périphérique; la présence d'air sous-dural gênait pour affirmer une atrophie corticale surajoutée. Les clichés simples ne manquent pas non plus d'intérêt. Ils nous ont révélé des calcifications intra-craniennes, dont certaines tapissaient les parois du cavum du septum dans 3 sur 4 des cas de toxoplasmose et des signes osseux importants d'hyperostose compensatrice avec microcéphalie dans les 3 cas où était associée une grosse atrophie cérébrale bilatérale.

Citerne interventriculaire (*15 cas*). Nous avons défini plus haut la citerne interventriculaire sur le plan anatomique. Son aspect radiolo-



a b c

Fig. 4. a) Face: image gazeuse médiane au-dessus de la clarté du troisième ventricule. b) Profil: plage gazeuse en virgule, oblique en arrière et en bas, distincte du troisième ventricule. (8 mois — Citerne interventriculaire, crises convulsives, retard psycho-moteur, microcéphalie, asymétrie faciale, palais ogival). c) Profil: la citerne en virgule est injectée en même temps que le système cisternal. Il existe de vastes plages d'atrophie corticale. (8 mois — un autre cas que (a) et (b).)

gique est très particulier: les clichés de profil en position assise donnent les images les plus probantes mais il est nécessaire de les compléter par les clichés habituels de face et de profil en décubitus et en procubitus.

Sur les clichés de face, une ombre gazeuse triangulaire ou trapézoïdale se projette à la hauteur du septum lucidum, renforcée latéralement par les ombres des ventricules latéraux et en bas par le troisième ventricule.

Cette image peut varier dans sa forme et selon le volume de cette citerne. Nous observons soit un petit nodule gazeux médian à peine visible, soit une fente gazeuse allongée et très étroite, soit une plage triangulaire ou trapézoïdale typique telle que nous l'avons décrite, soit enfin, une poche énorme à limites convexes, dépassant 2 centimètres de diamètre.

De profil l'image de la citerne interventriculaire est non moins caractéristique: plage gazeuse en virgule ou en massue, oblique en arrière et en bas, à grosse extrémité postéro-inférieure et à convexité supérieure. Son extrémité antérieure se situe à un centimètre environ en arrière des trous de Monro; elle s'incurve en arrière et en bas, pour se terminer à la hauteur du carrefour ventriculaire dans la citerne de la grande veine de Galien, se superposant parfois à la base de la corne temporale. En haut et en arrière elle répond à la partie postérieure de la face inférieure du corps calleux, confondue avec le psaltérium. En bas, elle est séparée du troisième ventricule par une bande claire correspondant au plexus choroïde et à la toile choroïdienne supérieure.

Les images peuvent varier dans leur forme et leur densité selon la taille de cette citerne, mais elles gardent presque toujours leur aspect en virgule ou en massue. Comparée à l'image du cavum de Verga, elle s'en différencie fort peu.

Deux arguments seulement permettent d'affirmer la réalité de la citerne interventriculaire et d'éliminer un cavum de Verga: il s'agit d'une cavité cisternale injectée seulement à l'encéphalographie gazeuse et invisible à la ventriculographie. C'est ce que nous avons pu vérifier dans un cas. Le cavum de Verga n'existe jamais isolé mais toujours associé à un cavum du septum; c'est du moins ce que nous ont appris les anatomistes.

L'étude pneumographique révèle en outre, très fréquemment, des lésions cérébrales associées: atrophie cérébrale diffuse, bilatérale prédominant parfois d'un côté (9 fois sur 13), atrophie corticale (2 cas), bilatérale dans un cas (associée à une atrophie globale), unilatérale dans un autre cas.

Un dernier point mériterait d'être souligné à propos de la citerne interventriculaire: sa pathogénie.

ZELLWEGER semble considérer cette citerne comme la conséquence d'une hypoplasie de la partie postérieure du corps calleux (vérifié dans 2 cas par cet auteur), mais il s'agit peut-être plutôt d'un processus d'hydrocéphalie externe, consécutif à une hémorragie meningée ou une méningite et ayant distendu les citernes de la base. Il n'existe en fait aucune pathogénie suffisamment étayée. Par contre, un élément reste certain: sa signification pronostique fâcheuse; dans les cas que nous avons pu suivre, l'aggravation des crises convulsives et du retard psycho-moteur est progressive et la plupart de nos enfants sont morts sans avoir atteint l'âge de 5 ans

RÉSUMÉ

Les auteurs ont étudié 45 cas de malformation du plan sagittal interhémisphérique du cerveau. Au point de vue étiologique, seule la toxoplasmose paraît avoir un rôle certain. Le tableau clinique le plus fréquent est l'association d'un gros retard psychomoteur et de crises convulsives. Chacune de ces anomalies a un aspect radiologique bien défini, conforme aux descriptions antérieures; la pneumographie montre de plus des lésions cérébrales associées, habituellement de type atrophique; le pronostic de ces malformations est très grave.

SUMMARY

Malformations in the interhemispheric plane of the brain based upon a material of 45 cases are discussed. Only toxoplasmosis seems to play a definite role as the causal agent. The most frequent clinical picture is one of generalized psychomotor delay combined with convulsive seizures. Each of the anomalies has characteristic roentgen appearances, as previously described, and these together with the associated cerebral lesions, usually of the atrophic type, are well shown by pneumography. The prognosis is poor.

ZUSAMMENFASSUNG

Die Verfasser berichten über 45 Fälle mit Missbildungen in der Mittelebene des Gehirns zwischen den beiden Hemisphären. Bezüglich ihrer Entstehung scheint nur die Toxoplasmose eine sichere Rolle zu spielen. Das häufigste klinische Bild ist eine bedeutende psychomotorische Trägheit, kombiniert mit Krampfanfällen. Jede dieser Anomalien hat ein genau definiertes röntgenologisches Aussehen, das mit früheren Beschreibungen übereinstimmt. Die Pneumographie demonstriert weiterhin assoziierte Gehirnschädungen, gewöhnlich atrophischer Art. Die Prognose ist sehr ernst.

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